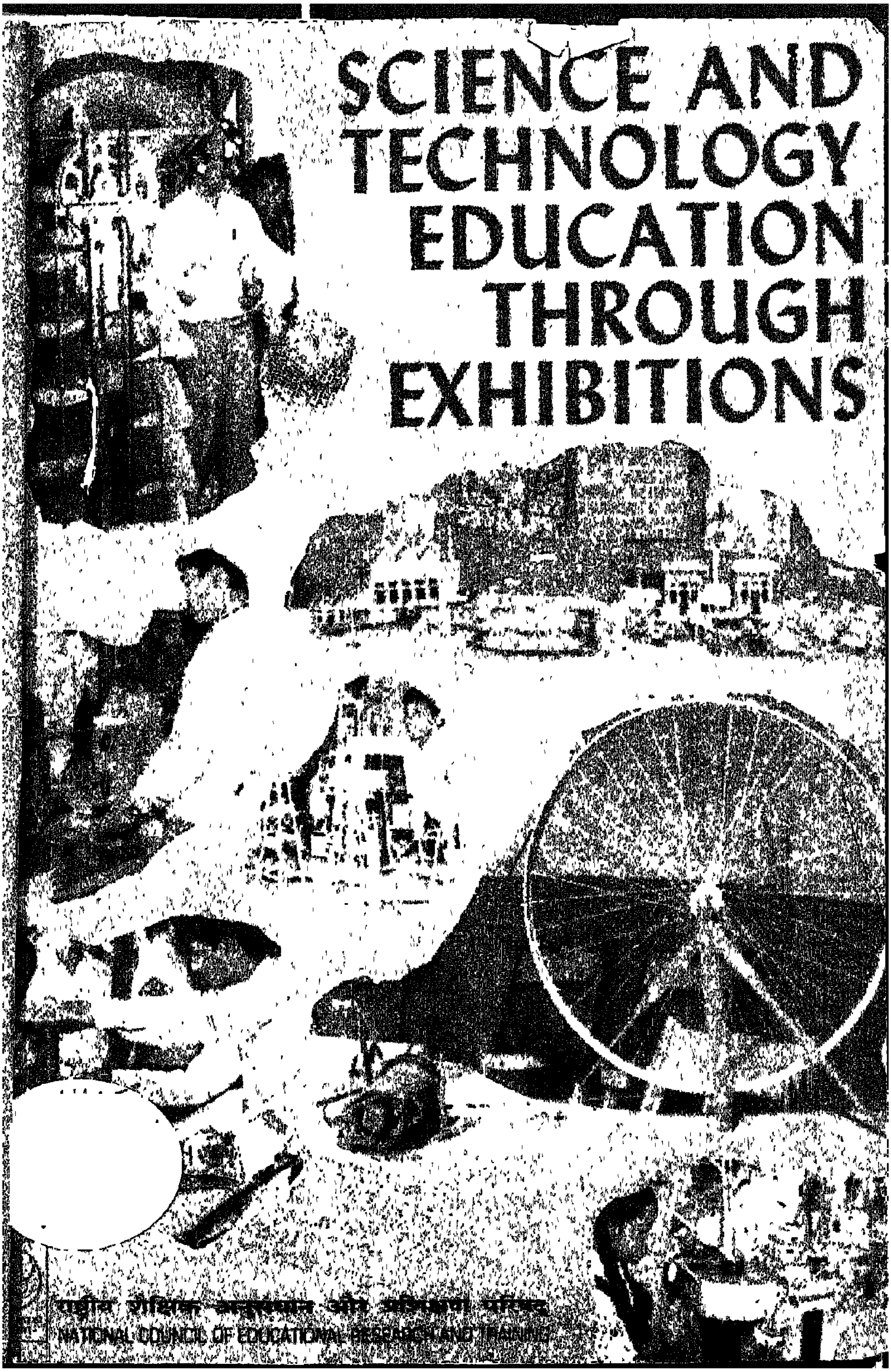
SCIENCE AND TECHNOLOGY EDUCATION THROUGH EXHIBITIONS



राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

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P K. Bhattacharyya

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NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

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FOREWORD

National Science Exhibition (NSE) for children was initiated and organised jointly the NCERT and the UGC for the first time in 1971 Pavilions were set up at the National ysical Laboratory and Bal Bhawan, New Delhi. During 1972-78, the Jawaharlal Nehru morial Fund collaborated with the NCERT in jointly sponsoring the state level ibitions The NSE was organised at Bombay (1979), Bangalore (1981), Calcutta (1982), cknow (1983), Udaipur (1985), Guwahati (1986), Jabalpur (1987), Jammu (1988), derabad (1989) and Patna (1990) in collaboration with the respective state governments. coincide with the birth centenary celebrations of Jawaharlal Nehru, the NSE has been named Jawaharlal Nehru National Science Exhibition (JNNSE) for Children. With the ticipation of children from all over the country in November every year, the JNNSE already a national movement in its own right. The Department of Education in Science d Mathematics of the NCERT is the nodal Department for organising the JNNSE every ar. Prof. P.K. Bhattacharyya who has authored this book is one of the very few members our faculty, who have been continuously associating themselves with the exhibition for e last 20 Years

In its last meeting, the Advisory Committee of the JNNSE discussed the quality of exhibits resented in the exhibitions It suggested that the participating students should be properly uided so that they can bring out ideas and principles of the exhibits very clearly through roper display. The need for a book introducing the basic tools required to work on wood, etal, glass etc. and their use in fabricating devices was also established. This book has een written basically for students on the lines of these recommendations.

In this book, the author has tried to arouse the interest of school students in science nd technology. The book will certainly guide students on all aspects of preparing science xhibits beginning from choosing the topic to the technique of display. It will also serve s a handbook for school teachers, who are guiding students in science club activities and looking after socially useful productive work/vocational/technical training Organisers of various science exhibitions are sure to find this book of great use while planning and mounting such exhibitions

We would welcome comments on this book.

Dr K. Gopalan
Director
National Council of Educational
Research and Training

8 September 1991

GANDHIJI'S TALISMAN

"I will give you a talisman. Whenever you are in doubt or when the self becomes too much with you, apply the following test :

Recall the face of the poorest and the weakest man whom you may have seen and ask yourself if the step you contemplate is going to be of any use to him. Will he gain anything by it ? Will it restore him to a control over his own life and destiny ? In other words, will it lead to Swaraj for the hungry and spiritually starving millions ?

Then you will find your doubts and your self melting away."

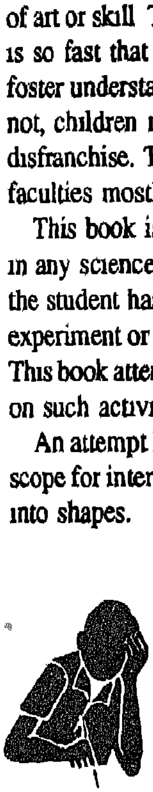
MKGandhi

INTRODUCTION

Technology is the purposeful application of man's knowledge of materials, source of energy and natural phenomena. Technology is derived from the Greek, *techne* (meaning art or skill) and *logia* (meaning science or study). Literally technology means the science or study of art or skill Technology is an inescapable part of life. Today advancement of technology is so fast that science curriculum can hardly keep pace with it. Schools therefore must foster understanding of technology and encourage creative attitudes towards it. If they do not, children may be over-awed and may tend to be passive recipients and technically disfranchise. The need is to develop awareness, inventive ability and application. These faculties mostly grow through participation in science exhibitions.

This book is intended for school students of the age group 13-18. Though the content in any science textbook at the middle, secondary or higher secondary stage is very rich, the student has very limited opportunity to learn by doing. If a student has developed an experiment or exhibit out of an occasional flambuoyance, his/her talent has to be nurtured. This book attempts to identify basic facilities required in the school and techniques to carry on such activities.

An attempt has been made to present facts in such a manner that the student gets enough scope for interaction This will help them in conceptualisation and in translating their ideas into shapes.



The first symbol given here indicates in the text that the student has to think over the problem, note down observations or solve it.

The second symbol indicates hands-on activities for the student.

The roles of teachers and organisers have also been kept in mind while writing this book. Without their guidance, the students cannot be successful in the preparation and display of exhibits. But the Teacher's role here has been seen as that of a facilitator, whereas the student has the full freedom. If the teacher happens (or aspires) to be a responsible in-charge of exhibitions and science clubs, this book will give him/her the necessary background of science exhibitions in the country as well as help him/her in guiding the students. Many activities in SUPW and technical vocational streams could be carried out with the help of this book The portions in this book particularly relevant to the teacher have been marked by the symbol $\boxed{T}$.

The organisers/managers of various science exhibitions who do not always have the opportunity of close interaction with school teachers and students will be able to derive some points of understanding with them after reading this book. Some portions of each chapter have been written keeping in view the expectations of the students from them. These portions have been marked by the symbol $\boxed{M}$

I acknowledge with thanks the help received from all my colleagues of Workshop Department. Sarvashri Prithvi Singh, Anil Kumar, G.D. Sharma, S.S. Wadhwa and A. Chakraborti deserve special mention for preparing illustrations and for surveying literature. Prof. G.L. Adhya and Prof. B. Ganguly, Dean (Academic) were kind enough to go through the manuscript. I am indebted to Shri R. Joshi, Dr. K.M. Pant, Prof. D.Lahiri, Dr. J.S. Gill, Prof. K.J. Khurana and other members of staff of DESM for their cooperation. We have been working in a team for the last twenty years in organising the JNNSE. I am grateful to the National Council of Science Museums (NCSM), National Council for Science and Technology Communication (NCSTC, DST), Bal Bhawan, Department of Non-conventional Energy Sources (DNES), Council of Scientific and Industrial Research(CSIR) for sending me their publications. Kerala Sastra Sahitya Parishath(KSSP) sent me some selected songs and dialogues of KSSP street plays; I am thankful to them. I am indebted to Prof. A.K. Ray of IIT, Delhi for his valuable suggestions. This book would not have been published in such a short time, but for the highly professional handling by the Publication Department. I would like to record my sincere thanks to the Head, Publication Department and his staff.

Furthering of science exhibition and science club activities in schools in the overall framework of popularisation of science in the country needs more interactions among all concerned—particularly students, teachers and organisers. Comments from readers will be gratefully acknowledged and the same will be incorporated in subsequent editions.

Dr. P.K. Bhattacharyya
Professor and *Head*
Workshop Department, NCERT

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I

Types of Exhibits and their Trend in the Jawaharlal Nehru National Science Exhibition for Children

In this chapter you will notice the trend in the design of exhibits which were prepared and presented by students in the Jawaharlal Nehru National Science Exhibition for Children during previous years 865 titles are given in Appendix-I and design of 11 exhibits are outlined here Non-conventional Energy Sources and Technology for Rural Development have been found to be the major fields which are attracting students increasingly. Current research and development work carried out in these areas in our country have been briefly discussed These will help you to choose your topic in the next science exhibition.

1. Analysis of Exhibits Displayed in the Jawaharlal Nehru National Science Exhibition for Children during 1985-1990

The National Science Exhibition for Children, which is organised every year by the NCERT, made its humble beginning in 1971 at New Delhi. By now it has acquired the form of national movement and has become the culmination point of a multi-tier exhibition system Every year the first level exhibitions are organised at the district level which are followed by zonal or regional level exhibitions and then by state level exhibitions. Finally the selected exhibits from state level exhibitions are considered for the national level exhibition next year. The whole cycle thus takes two years. At every level the participants have to pass through a healthy competition in order to move to the next level. Though the number of exhibits displayed every year at the national level science exhibition is about 144, the actual number of exhibits prepared and displayed in district and state level science exhibitions all over the country run into thousands The designs of some of the national level exhibits are reproduced in Figs 1 to 11

The National Science Exhibition was held for the first four years in Delhi and as such had no particular theme Besides students and teachers, institutes and public sector undertakings were also invited to demonstrate research findings, development and application of technology during those years Since 1975 the participants are being given a particular theme every year:

1975—Man and Environment
1976—Technology and Rural Development
1977—Science in the Service of Man
1978—Science in the Service of Man
1979—Science and Village
1980—Science in our Environment
1981—Science in our Environment
1982—Science and Community Development
1983—Science and Technology for Productivity
1985—Indigenous Technology for Development
1986—Science and the Home
1987—Science and the Quality of Life
1988—Water and Man
1989—Science and Man
1990—Nehru and Science
1991—Science and Village

Alongwith the theme, sub-themes were also structured as given below.

Year	*Theme*	*Sub-theme*
1985	Indigenous Technology for Development	—Agriculture —Cottage industry —Indigenous technology and industrial development —Technology for communication —Technology in the aid of the handicapped —Indigenous technology for health —Technology and women —Technology for teaching aids
1986	Science and Home	—Energy saving devices —Food, health and nutrition —Testing of household materials for their quality —Cleanliness and sanitation —Home and aesthetics —Industry at home —Science and superstitions

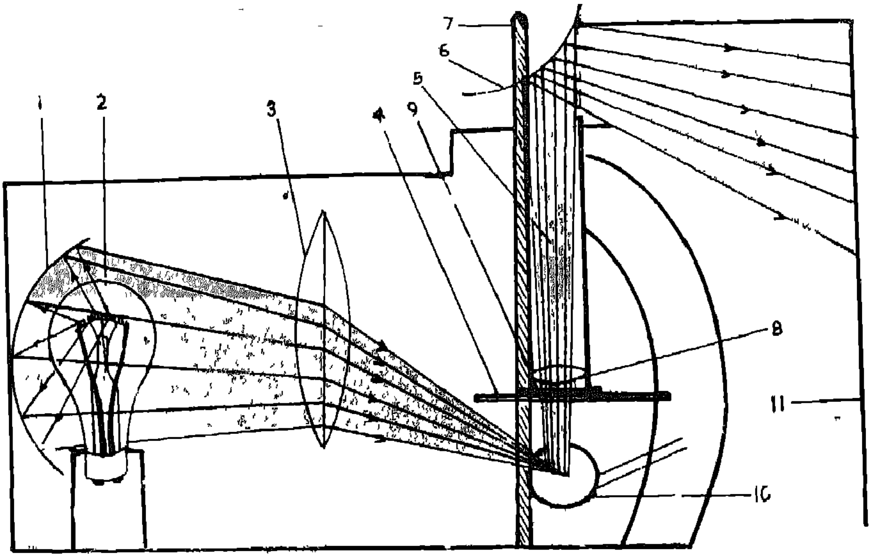


Fig 1 Improvised microprojector—1983: (1) concave mirror (2) bulb (3) convex lens (4) stage (5) barrel of the microscope (6) convex mirror (7) stand (8) optic lens (9) slide (10) reflecting mirror (11) screen

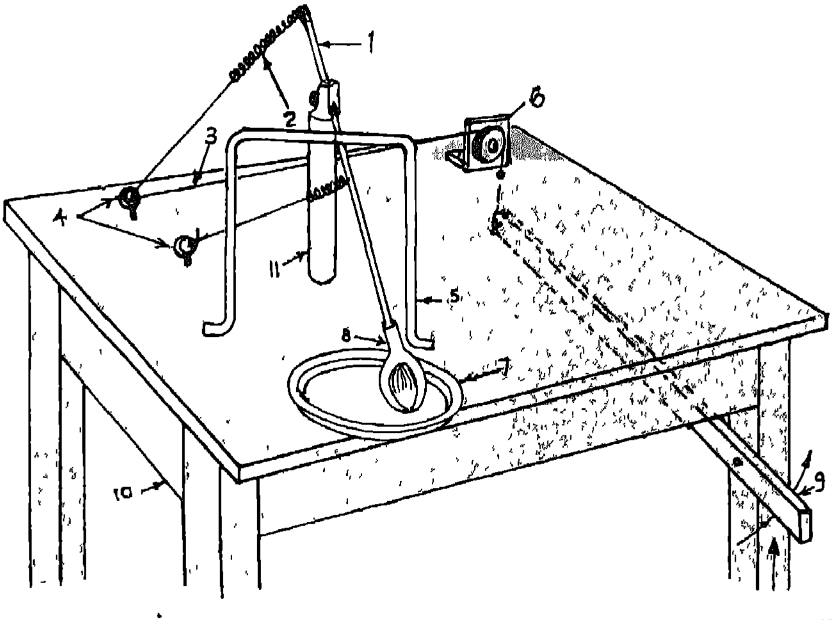


Fig 2 Parts of the feeding machine for the handicapped-1982 (1) An umbrella stick (2) spring (3) nylon string (4) hooks (5) iron stand for fixing the height of the spoon (6) pulley (7) dish for food (8) metal spoon (9) wooden strip (10) table and (11) hollow cylindrical tube

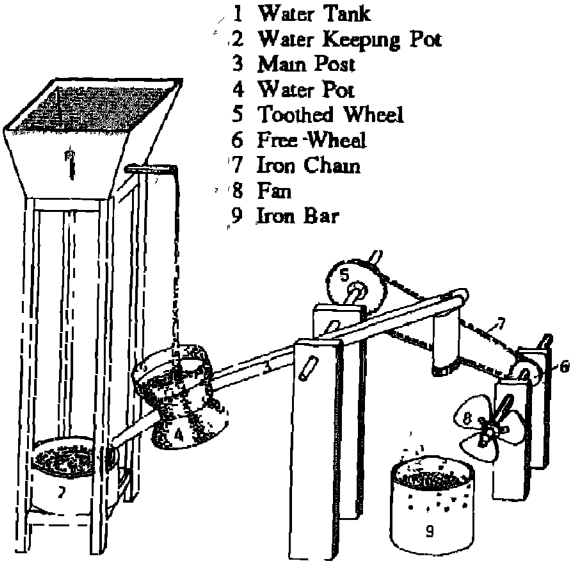


FIG. 3 Water *dhanky* (paddy crusher)-1988

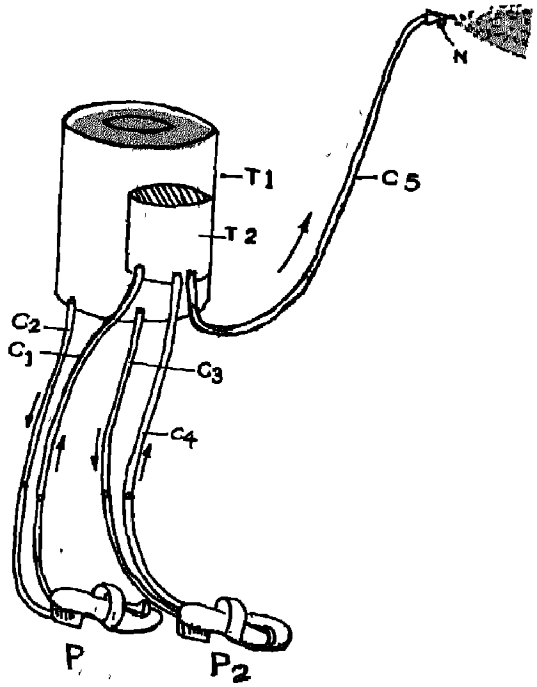


FIG 4. Spray while you walk-1983 T_1· tank no 1, T_2· tank no 2, C_1-C_5 tubes, P_1 and P_2. pumps, N-nozzle

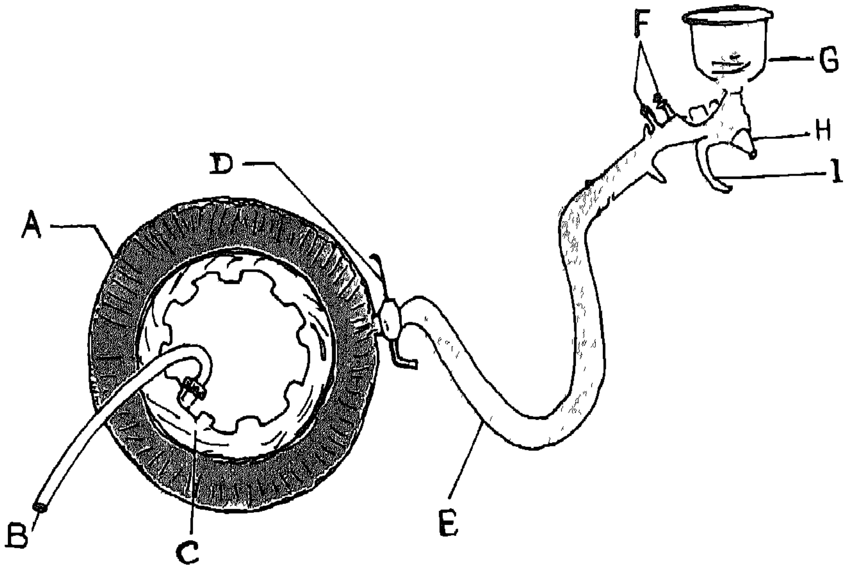


Fig 5 Parts of the indigenous paint sprayer-1985· A-old tyre & tube of scooter/motorcycle, B-attachment with cycle pump, C-inlet, D-regulator, E-rubber tubing, F-air adjustments, G-paint container, H-spray gun, I-throttle

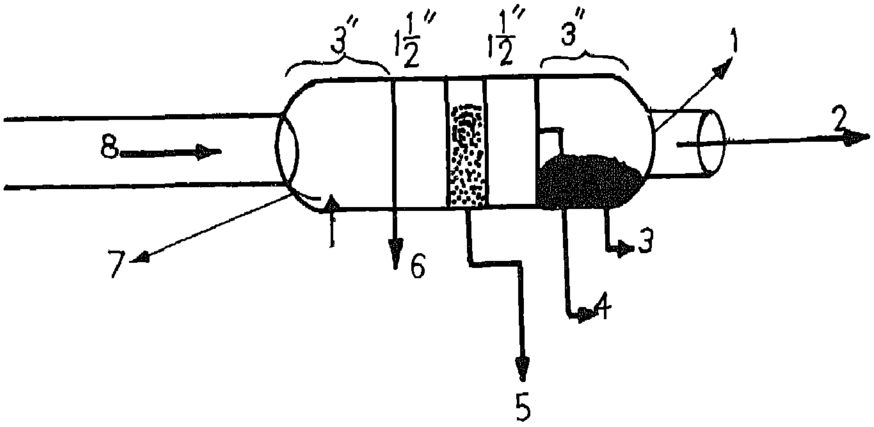


Fig 6 Anti pollution filter device-1983 (1) porous partition (2) outlet (3) compartment III (4) solid KOH (5) compartment II-Iron powder between porous asbestos sheets (6) porous dust filter (7) compartment I (8) smoke inlet

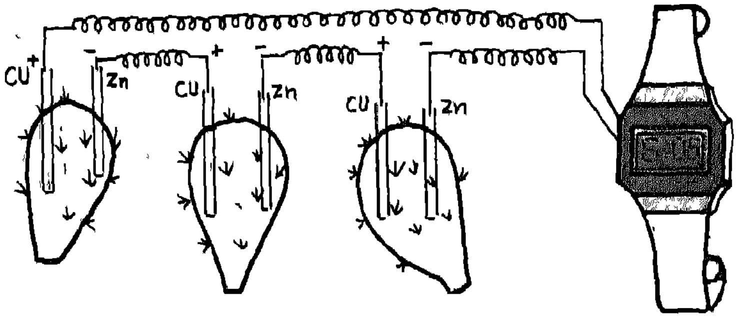


FIG 7. Bio-EMF from desert plant (OPUNTIA)-1989· 500 mv-800mv for Watch

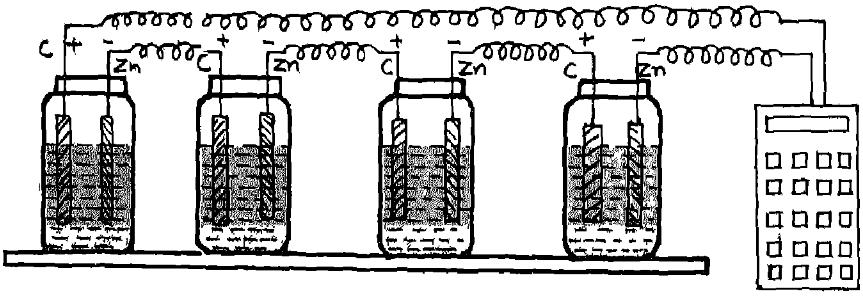


FIG 8. Bio-EMF from cow dung-1989 (75% dung + 25% salt)

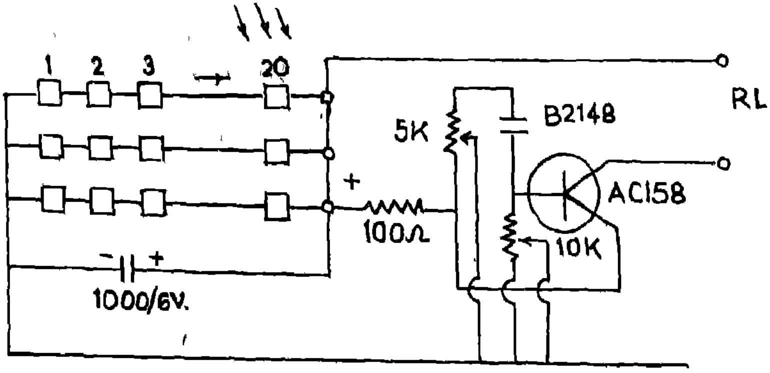


FIG 9 सोलर कार–1983· 1,2,3 .. ट्रांजिस्टरों (खराब) के ऊपरी खोल काटे गये, 3V, 750mA प्राप्त हुई।

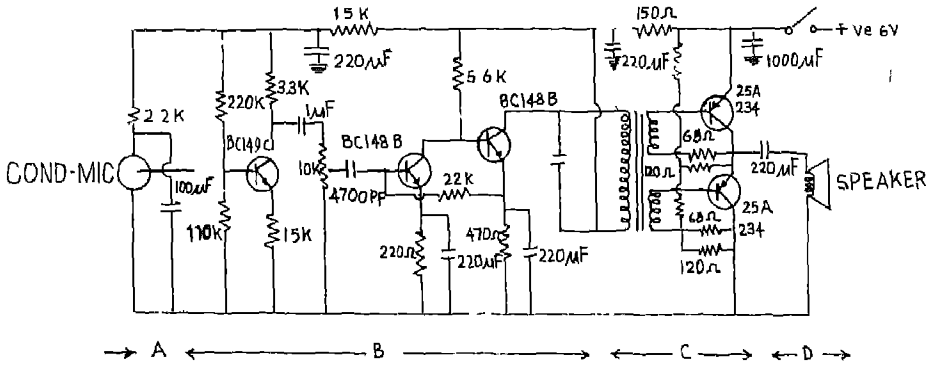
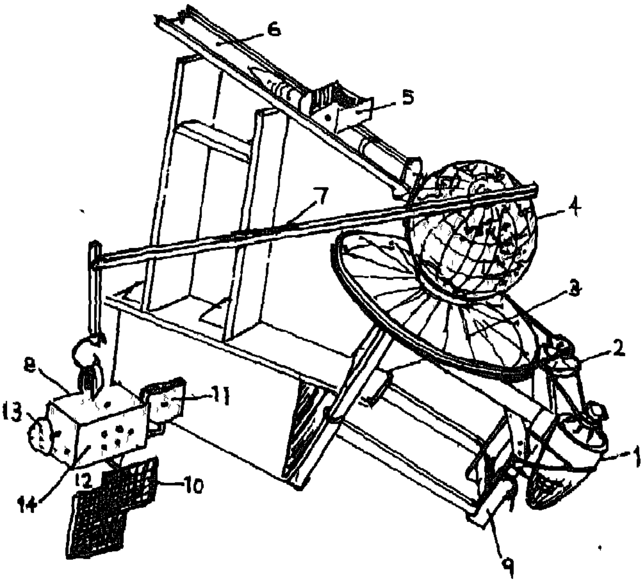


Fig 10. Speaking Aid for the dumb-1985
A, D-Transducer, B-Preamplifier, C-Amplifier



1 Fan Motor
2 Children Cycle Wheel
3 Bicycle Wheel
4 Globe
5 Challenger
6 Track for Space Craft
7 Rod for Showing Earth's Distance from INSAT-1B
8 INSAT-1B
9 Stool (Wooden)
10 Solar Panels
11 C & S Band Antenna
12 Solar Sail
13 C Band Antenna
14 U H F Antenna shown by Disco Light

Fig 11 Model of INSAT-1B-1985

Year	*Theme*	*Sub-theme*
1987	Science and Quality of Life	-Food, clothing and shelter -Natural resources -Health -Transport and communication -Science, technology & industry -Aesthetics and entertainment -Educational aids
1988	Water and Man	-Properties of water -Water management -Oceans -Pollution -Water and health -Uses of Water
1989	Science and Man	-Landmarks in science -Harnessing energy -Agriculture -Environmental management -Health -Transport & Communication -Science for entertainment -Educational aids.
1990	Nehru and Science	-Agriculture -Energy -Food, health & nutrition -Science, technology and industry -Transport and communication -Teaching aids and innovations

It has been observed that though there is an increase in the number of entries at the district and zonal levels over the years, the finish and display techniques offer scope for improvement. The exhibits displayed in the JNNSE during 1985 to 1990 have been analysed here in order to assess the trend. These may be classified under six major areas

(a) Improvised apparatuses, models and teaching/ learning equipment on general science, mathematics, space, entertainment etc.

(b)	Communication and Transport	CT
(c)	Energy	EN
(d)	Agriculture and Food	AGF
(e)	Environment, Pollution and Health	EPH
(f)	Industry and Innovation in Technology	IT

Any exhibit will pertain to one or more of the above six areas The title of the exhibit, year of presentation at the JNNSE, type of model have been tabulated under each of above areas in Appendix-I It can be seen from Fig 12 that the total number of exhibits displayed at the JNNSE has been 865 during six years (1985-90) On an average 144 exhibits were displayed every year. Of the 865 exhibits, 516 (60 per cent) were working models, 323 (37 per cent) were static models and remaining 26 (3 per cent) were charts and flow diagrams. The numbers of static models during last four years have been very high The static models generally do not create much interest in the viewers.

It is apparent that "Improvised Apparatuses, Model (IA) is the most favourite single area with a score of 378 This is followed by AGF, IT, EN, EPH and CT (Table 1) Exhibits on IA were mostly invited as per the structure of sub-themes given here The influence of theme on area appears to be very mild when we observe that in 1985 (theme: Indigenous Technology for Development) entries in IT and AGF were much less in comparison to those in IA, we find the highest number of exhibits on IA in 1987 (Science and Quality of Life). In 1986 (Science and Home) and in 1988 (Water and Man) when entries in IA were not even invited, we find a good number of exhibits on IA Students find it easy to prepare small models (with or without improvisation) of existing teaching/learning equipment This is quite natural But repetition of ideas or designs should be discouraged

It is to be noticed that the exhibits on AGF, EN, EPH and IT may be grouped under Non-Conventional Energy Sources as well as Technology for Rural Development; the total number of such exhibits scores over the number of exhibits on IA By and large one can see gradual improvement in the innovative feature of exhibits and strong influence of contemporary technology on the design. Examples are generous use of solar cells, ICs in circuits, remote control, etc Contemporary events like satellite communication, magnetic levitation, rocket launching etc are also faithfully demonstrated through models, charts, Interestingly, innovative designs which did not exist earlier are being seen in the exhibition e g Spray while You Walk, Water *Dhanky*, Solar Car from Discarded Transistors, etc

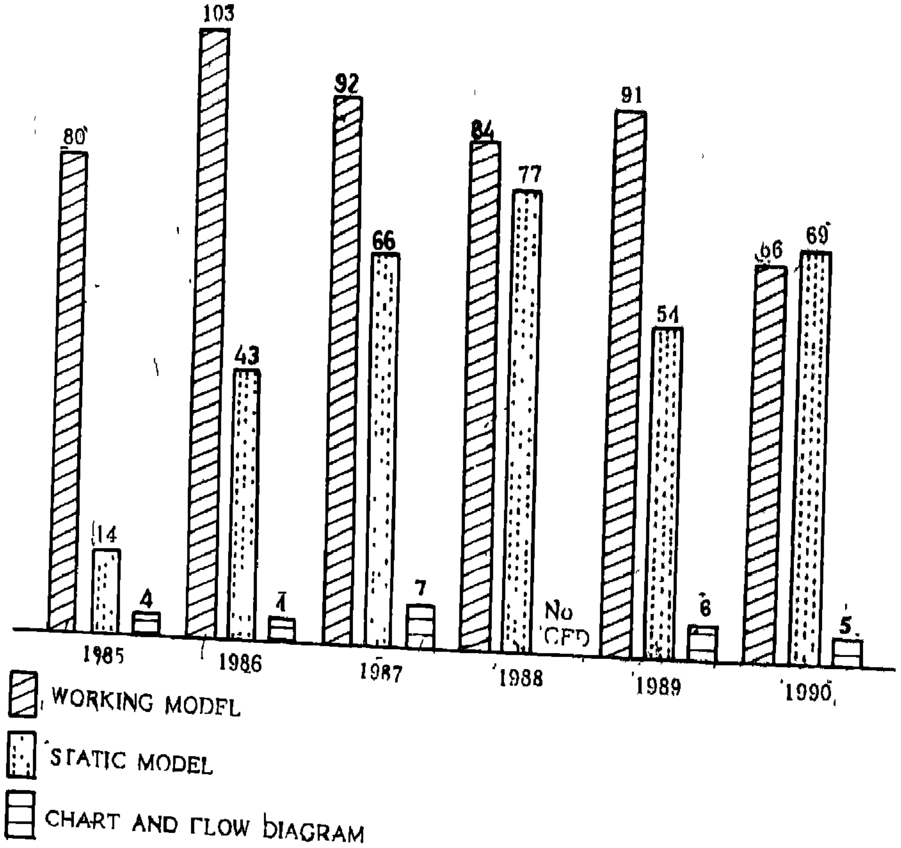


FIG 12. Yearwise distribution of working models, static models & chart and flow diagrams. Total no. of exhibits 865 (during 1985-90).

From the analysis and the titles of the exhibits given in Appendix-I, a distinct trend to develop exhibits showing current innovations in:

(a) non-conventional energy sources, and
(b) technologies for rural development

has been observed.

This is timely and in tune with the strategies to meet the contemporary challenges of growing population pressure, dependence on oil import and shortage of energy. Before you attempt any model in these areas, it will be worthwhile to take stock of development work already done in our country You have studied biogas,

TABLE 1 **Analysis of 865 Exhibits Displayed during 1985-90**

Areawise classification of exhibits	*1985 Indigenous Technology for Development*	*1986 Science and the Home*	*1987 Science and the Quality of Life*	*1988 Water and Man*	*1989 Science and Man*	*1990 Nehru and Science*	*Total*
(a) Improvised apparatus and mode(IA)	41	61	86	72	65	53	378
(b) Communicaton and Transport (CT)	8	5	23	5	25	24	90
(c) Energy (EN)	13	25	13	44	45	33	173
(d) Agriculture and food (AGF)	28	44	35	29	35	36	207
(e) Environment, pollution and health (EPH)	12	22	31	52	26	21	164
(f) Industry and innovation in technology (IT)	27	30	35	26	32	51	201

biodegradable wastes, productivity in the primary sector with improved technology and implements etc. in your textbooks of science and geography Development work in these areas currently going on in our country are briefly given here These have been compiled from References at Sl Nos. 4 to 10 given at the end of this Chapter For detailed information about a particular programme or design, you may write to the departments/institutes whose addresses are mentioned in the References

Fill in the blanks

(a) 17% of world-wide carbon dioxide come from motor vehicles. Carbon dioxide is responsible for ______

(b) A cyclist can ride 16 km using 350 calories of energy (the amount in one bowl of rice). The same trip in a car uses ________ calories or nearly ____________ litres of petrol.

2. Non-Conventional Energy Sources .

Growing energy need of our country can't be met by the power plants alone. Decentralised energy systems are to be inceasingly developed to feed agro-industrial and household sectors in rural areas. Sun, wind, biogas, petrocrop are prominent among such non-conventional sources

2.1 Biogas Waste Recycling and Resource Recovery

Upto 1989 over 533 community/municipal type biogas plants were installed. Waste of almost any type can be used in these plants These are bio-degradable wastes from sewage system, municipal and community wastages, sugar and textile mills, distilleries, etc. These may be called "mini gas-fields". The enriched manure is free from weed seeds and many pathogens This manure results in the increase of crop yield A total of 70979 latrine-linked biogas plants have been installed upto 1989. Micro-biological and bioprocess engineering of methane production was initiated in 1989 Besides, many institutes are carrying out research to improve the rate of gas production per unit weight of dung/waste mainly through manipulation of micro-organisms and biodigestability. *Cellulomonas fimi* has been identified as an efficient cellulose degrading organism Researchers are also studying decomposition of wheat straw, rice straw, edible oils etc. Biogas generation from non-edible oil seeds such as Palas, Castor, Neem and Mohua were tried. Biogas plant using kitchen waste, dried banana stem, eucalyptus leaves and composite agricultural residues and water hyacinth have been developed. Water hyacinth purifies domestic sewage efficiently Plug flow digestors made of polyethylene flat tubes have been developed for biogas generation from water hyacinth and other terestrial weeds such as *perthenium*

Research on burner design has revealed that the burner efficiency depends on pan-height over the burner-head. Though primarily used for cooking puposes, the biogas can be used for small scale power generation, lighting, running flour mills, pumping drinking water, irrigation, milk chilling etc. One of the largest community biogas plants in village Maithon (Gujarat) provides cooking gas for 350 families for 8 hours a day The biggest plant in Asia comprising of 7 units of 140 cubic metres was installed at village Jamalpur in Ludhiana recently This provides gas for 275 families for 8 hours

2 2 Biomass

Growing requirement of fuel, fodder and power demands development of fast growing species of trees and plants Technologies for production of woody trees and shrubs in wastelands for fuelwood are being developed. Investigation has resulted in the identification of major fuelwood species Biomass potential of 31 fuelwood species comprising of leguminous, non-leguminous, indigenous and exotic species were carried out. The *C Siamea* which was found to be the most suitable fast growing species, yielded maximum dry biomass of 59 23 tons (42 months) per hectare. The calorific value and ash content of woody and leafy parts were also studied. Experiments on seed germination, seedling growth, physico morphological and nodulation studies, regeneration through tissue culture are being carried out Germ

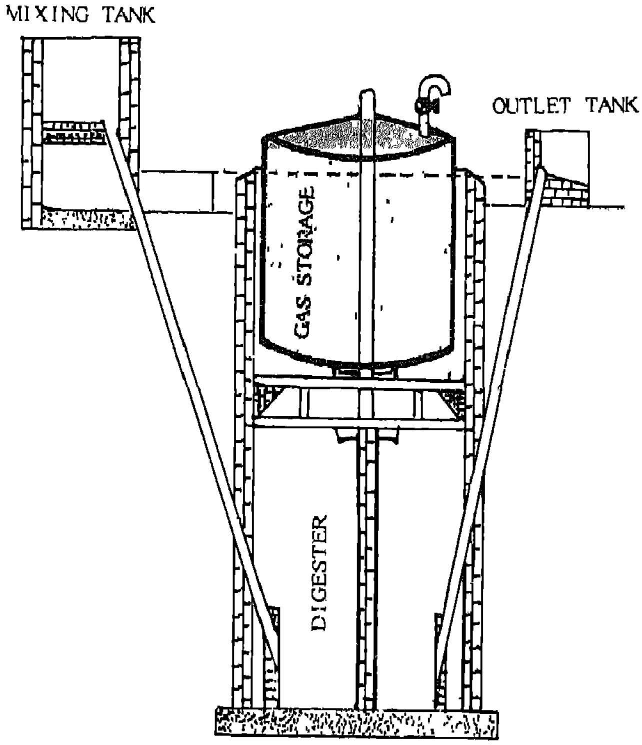


FIG. 13 Floating Gas Holder Type Biogas Plant

plasm banks are being established in research centres in order to collect and preserve the germ plasm of woody species

Petrocrop research farms are being established. Some of the hydrocarbon yielding plants have been selected for investigation. Latex bearing plants have considerable potential for production of biochemicals and liquid fuels. Latex from petrocrop can give out low molecular weight, non polar constituents (biocrude) and catalytic cracking seems to be a promising alternative for production of hydrocarbon liquid fuel Latex from *Euphorbia* species can be utilised for obtaining petroproducts for applications like adhesive, water resistant coating for wood, corrosion resistant coating for metal, moisture and insulation coating for paper, enamel paint, water thinable emulsion paint, film to curb water evaporation, water proof coating for mud houses etc. *Jatropha curcus* is an oil bearing plant and is an important renewable source of energy which can substitute diesel. It grows in the wild in Rajasthan and its seed contain 33% oil. From the point of view of recovery of biocrudes and subsequent conversion to hydrocarbon fuel, 17 plant species have been identified as potential petrocrops. Rudolf Diesel, inventor of diesel engine used peanut oil as fuel during a demonstration. In IIT-Madras technologists found that pure vegetable oils could be used in diesel engines without major problems. Palm oil, rice bran oil, karanji oil (*Pongamia Glabra*) are some suitable alternatives to diesel.

Aquatic biomass programme constitutes production and utilisation of marine photosynthetic biomass. The blue-green algae system is capable of producing hydrogen due to biophotolysis of water and the oxygen liberated inhibits the enzyme system responsible for production Enhanced rate of hydrogen generation is obtained with co-culture of bule-green algae with a photosynthetic bacterium and a heterotrophic bacterium. A new nonconventional source of energy in the form of lipid and hydrocarbon has been found in algal *Botryococcus*. A process has been developed for catalytic hydrogenation of jojoba oil to jojoba wax using indigenous commercial catalyst Sweet sorghum juice is a potential source of liquid fuel A maximum of 7.6 percent (v/v) ethanol could be obtained by fermenting juice from sweet sorghum having 12 per cent sugar

Biomass gasification systems and stirling engines of various ratings have been developed and tested in many research centres. A gasification system can be designed for any one or more of wood-waste, paddy straw, sugarcane trash, soda ash, coir pith, mustard stalk, groundnut shell etc. Such a system consists of gasification reactor, air pre-heater, air distributor, material handling arrangement, cyclone separator, water scrubber, dry filter etc. Gasification efficiency in the range 65-75 is generally achieved

2.3 Solar Thermal Energy

Low grade solar thermal technology which can meet thermal energy requirement for temperature applications below 100°C has been developed. These applications are air heating, drying, space heating, water desalination Solar water heater, solar timber kiln, solar air heater are other devices now in use in many places. For applications in cooking, steam generation for industrial application, drying, refrigeration, pumping etc (application in the temperature range of 100°-300°C), selectively coated all glass and metal to glass evacuated tubular collectors have been developed An indigenous small size refrigerator is being developed. Development of small refrigeration unit based on zeolite is also being attempted. Research is being carried on to develop a solar thermal pump capable of drawing water from a depth of 40-50 m Solar heating systems are in great demand in industries, canteens, hospitals etc Systems of capacity ranging upto 1,20,000 lpd have been installed

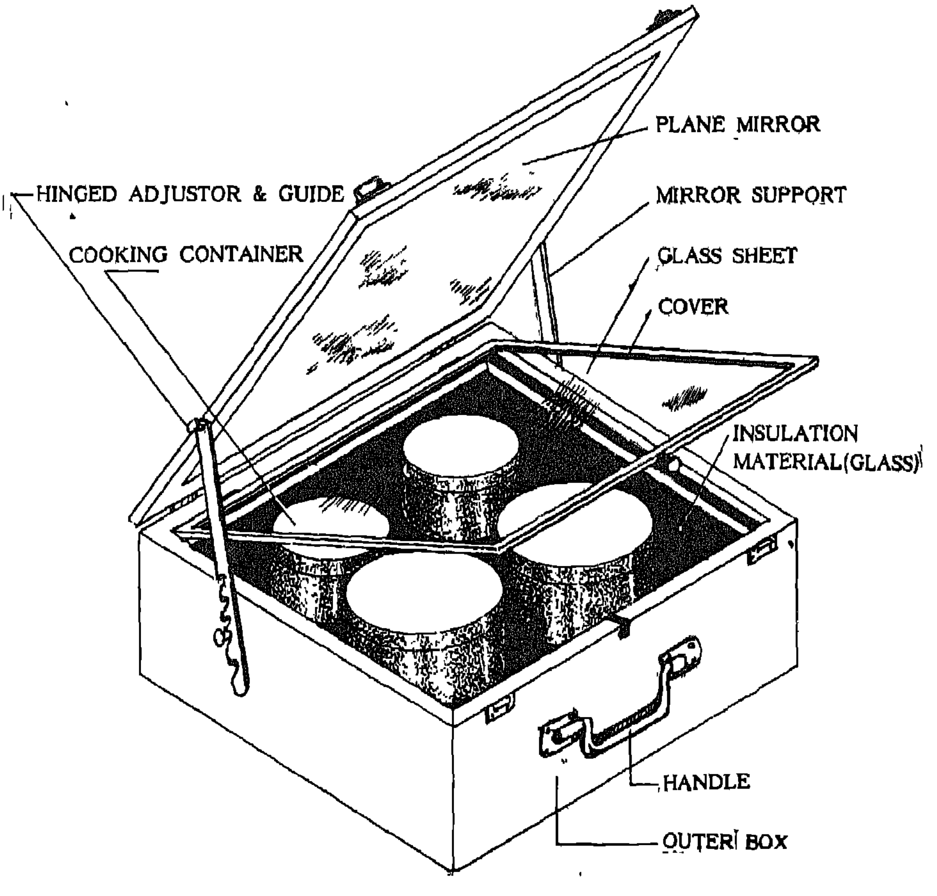


FIG. 14. Solar Cooker

A number of systems with Evacuated Tubular Collector Technology have been installed for applications in sterilisation in hospitals and providing heat energy input to the Acqua Ammonia Chiller. The cumulative collector area of all solar thermal energy systems installed in the country so far will be about 1,19,471 sq. m generating 80.64 million kwh thermal energy equivalent per annum.

Two experimental solar thermal power plants based on point focussing and line focussing collectors in conjuction with steam turbine have been installed at Salojipally village near Hyderabad and Solar Energy Centre, Gwalpahari. A solar pond of 6000 sq.m area and 4 m depth is being commissioned at Bhuj to meet the process heat requirement of Bhuj Dairy. Standard designs of various types of energy efficient houses under different climatic conditions are being brought out. Solar huts and green houses have been constructed in Ladakh. Solar passive houses have been built in the IIT-Delhi campus

Two models of Solar Kier, one of 25 kg per day capacity and the other of 125 kg per day capacity have been developed. The bigger kier can process 1500 -2500 meters of fabric in one lot. Various designs of solar cookers are now available in the open market. Regular use of family type solar cooker saves 12 kg of wood per day. Solar cookers sold till date might have saved 184 million kg of wood per year.

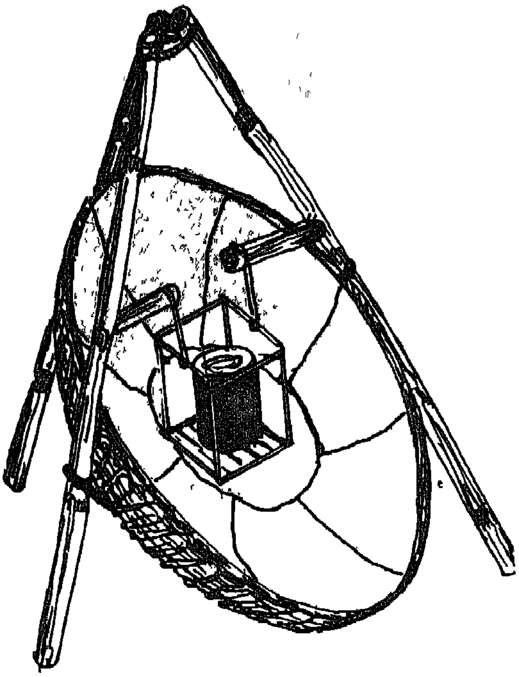


FIG 15. Solar Cooker made of low-cost materials from local resources

2.4 *Improved Chulha*

Usually local clay, chimney, pottery or ceramic liner etc. are used in constructing fixed and portable chulhas Chulhas can have provision for one, two or three pots. Traditional chulhas have thermal efficiency of about 5-10 per cent, whereas minimum thermal efficiency of improved ones are over 20 per cent (fixed models) and 25 per cent (portable ones). Traditional chulhas are to be mud washed every morning and evening as a part of the daily routine cleaning This labour will be saved with the development of the pottery lined chulhas. It is possible to save fuel to the extent of 40 - 50 per cent by installation of improved chulhas. The present 'Community model' is suitable for 50-1000 persons.

R&D efforts are being made to develop efficient briquetted fuel chulha, rice husk chulha and saw dust chulha. Portable chulha with mild steel, cast iron, stainless steel etc can ensure durability and long life. *Swosthee, Kishore, Deepshika* are some of the models. By now there are about 80 lakh improved chulhas. If these are used regularly there will be an annual saving of 56 lakh tonnes of wood valued at Rs 224 crores per annum.

2.5 *Wind Energy*

Wind resources has a potential in excess of 20,000 MW of power generation alone. 9 wind farm projects of 10.10 MW aggregate capacity have been installed. A total of 2524 water pumping wind mills are already working in various places. The latest wind pump has a rotor of 4 m diameter and a pump of 75 mm diameter. These are capable of pumping 8000 litres of water per day from depths upto 50 m

The performance of 30 kW vertical axis wind turbine is under study. Indigenisation of small battery charging system of rating from 50 W to 5 kW is being attempted A 5HP diesel pump set operating for 5 hundred hours annually pumps out water at a cost of 45 paise per cubic metre In wind pumping system (12-PU-500) the cost of water pumped out works at 25 paise per cubic metre at a total head of 6 metres and annual output of 20,000 cubic metres. On an average a wind pump can save about 1.28 tonnes of diesel or 2000 kWh of electricity annually under favourable conditions.

2.6 *Solar Photovoltaics (SPV)*

Indigenous polysilicon material and single crystal wafers made out of this material are already in use in the industry. SPV power plants are being constructed. Solar refrigeration systems are being developed In Amorphous Silicon Solar Cell Technology, small solar cells of 1 sq. cm size with 11 per cent efficiency have been developed. Higher deposition rates and uniform deposition on large area of 100 sq.cm have been achieved.

About 6628 villages and hamlets have been benefitted by SPV Street Lighting Systems (Fig. 173); moreover numerous community/domestic lighting and TV units have been installed. 1150 SPV water pumping systems have been installed by now. Each system uses 360 Wp PV array and lifts 20,000 litres of water per day (total head 7-8 metres) using DC monoblock motor pumps. Small PV power plants of 1-5 kWp have been installed in many villages. Battery charging, railway signalling, panel inter-locking, cathodic protection of oil and gas pipelines, weather monitoring, microwave repeater stations, telephone exchange, satellite ground stations, TV transmitter, two way radio—are other areas of application of SPVs

2.7 *Human and Animal Energy Programme (HAEP)*

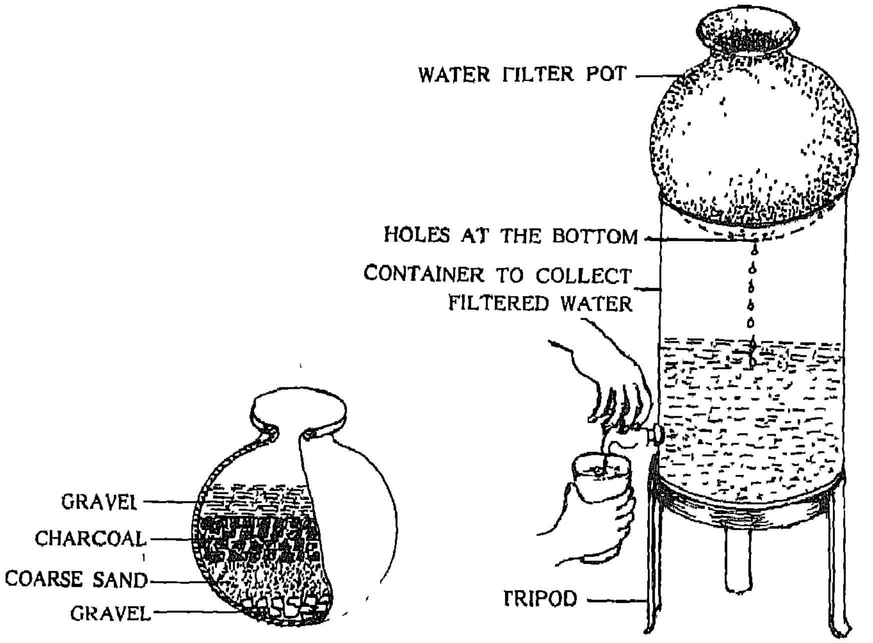
Draught animals contribute 6-10 per cent to country's GNP. On the average each bullock or buffalo is capable of generating half horse power. The total horse power generated by the existing draught animals is around 40 million HP. Production and distribution of this power will require an investment of Rs. 30,000 crores Nearly 3.9 million non-powered carts are used in transporation in urban areas. Only one tenth of these are driven by animals, rest by human muscle. The urban cart system employs about 1260 million mandays of employment annually Therefore there is enough scope for designing efficient material handling and transporting systems which will require Draught Animal Power (DAP) and/or Human Muscle Power (HMP). Various models of carts, system for harnessing animal power for generation of electricity for rural household, efficient unit for animal operated pump are being developed Leaf cup, leaf stitching and rope making machines are already in use

2 8 *Others*

Micro and mini hydel development, magneto hydrodynamics, hydrogen energy programme, chemical sources of energy (photoelectrochemical cells, fuel cells etc), ocean energy, geothermal energy are other areas of current research and development. Battery operated vehicles are being manufactured by BHEL-Bhopal. Use of compressed natural gas in internal combustion engines is being tried. Geothermal energy from 340 hot springs localities in our country will prove to be very useful source of energy.

3. Technologies for Application in Rural Areas

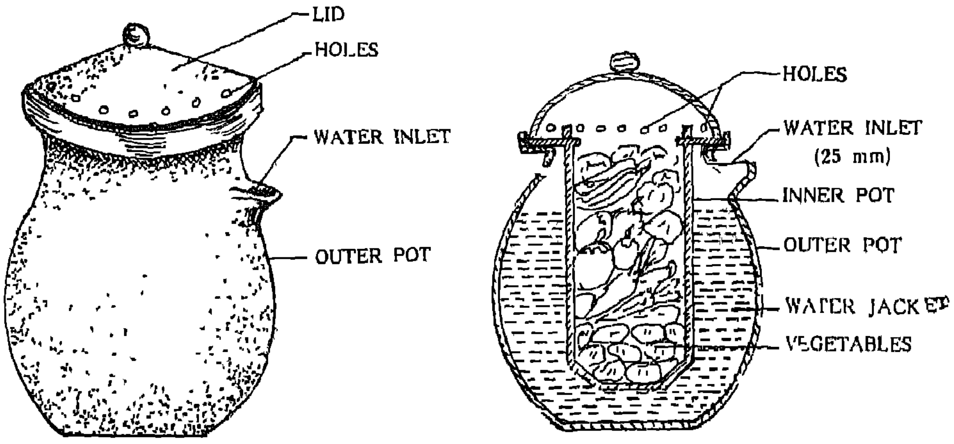
These may be subdivided into. technologies for cleaning water and environment, agro based (including medicinal and aromatic plants), spice based, cultivation and processing (including oil and plant drugs), fermentation based, forest based, poultry based, marine based technologies, agriculture tools and implements (including building materials). Such technologies have been developed in CSIR laboratories



WATER FILTER POT

COLLECTING FILTERED WATER

FIG 16 Charcoal Water Filter



COMPLETE UNIT

VERTICAL SECTION

FIG 17 Sheetal Pot

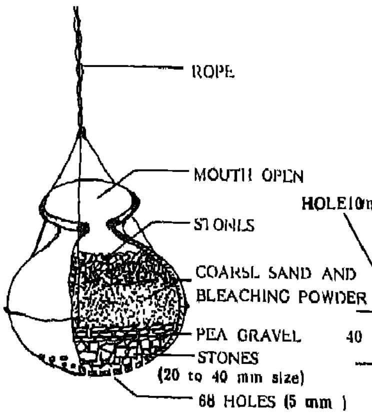
agricultural universities and other institutions in our country. Some developments are briefly described here (References 5 & 6).

3.1 Charcoal Water Filter

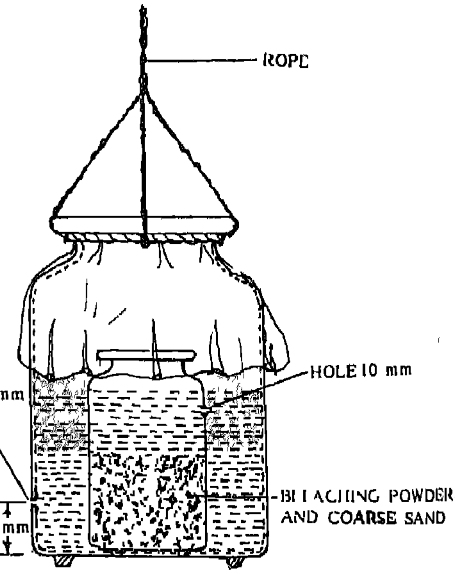
Each of gravel, coarse sand, charcoal, gravel layers is respectively 25,25,15,10 cm thick The total thickness is about two-third of the clay pot having 42 cm diameter and 100 cm height (Fig 16) This has been designed by National Environmental Engineering Research Institute, Nagpur-440020.

3.2 Sheetal Pot

The telescopic clay pots are to be made to order as shown in Fig 17 Heat from the eatables in the innerpot (350mm dia × 400mm high) is extracted as water evaporates through the pores of the outer clay pot (500mm dia). A difference of 11°C can be achieved if the pots are clean and water is changed daily. This is designed by Centre of Science for Villages, Ceramic Unit, Magan Sangrahalaya, Wardha-442001.



SINGLEPOT SYSTEM FOR COMMUNITY WELLS



DOUBLE POT SYSTEM FOR HOUSE HOLD WELLS

CHLORINATION POT FOR WELLS

FIG 18

FIG 19

3.3 Chlorination Pot for Wells

As in Fig. 18, a pot of 7-8 litres capacity with 6-8 holes is filled with stones, sand and 1.5 kg of bleaching powder. This is lowered in a community well where 900-1300 litres are drawn daily. Chlorination is done every 2 weeks.

Double pot (Fig. 19) is suitable for smaller wells where 360-450 litres of water are drawn daily. The inner pot has 1 kg of bleaching powder and 2 kg of sand.

These have been designed by National Environmental Engineering Research Institute, Nagpur-440020.

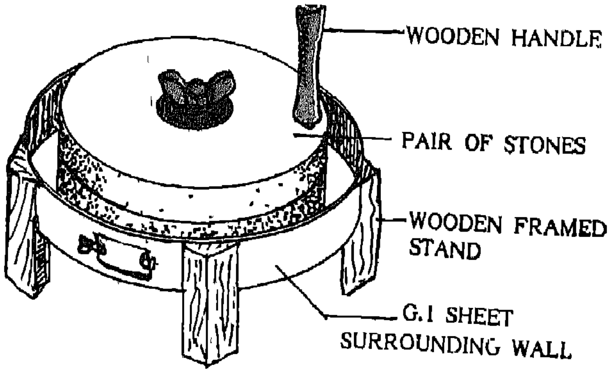


FIG 20 Improved Hand Chakki

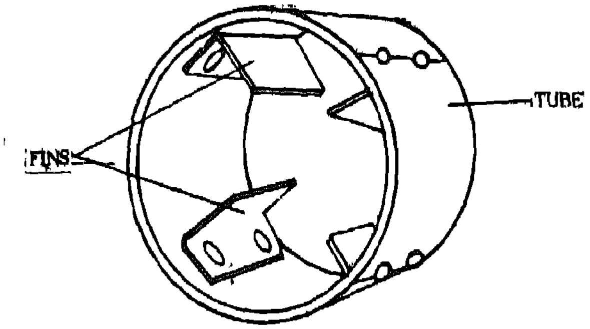
3.4 Improved Hand Chakki

The two-stone chakki can grind 3 kg of wheat flour per hour. This is designed (Fig. 20) by the Centre for Development of Rural Technology, Institute of Engineering and Rural Technology, 26 Chatham Lines, Allahabad -211002

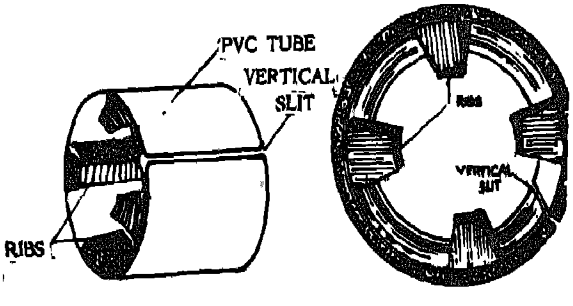
3.5 Maize Sheller

The sheller is held on the left hand while a maize cob is inserted and rotated with the right hand. The kernels are thus knocked off the cob. The output is about 15-23 kg per hour. As shown in Fig. 21 four mild steel fins bent at 70° are fitted nside a ms pipe of 62.6 mm diameter. The tapered ends of fins provide two openings—one of 39mm diameter on one side and the other of 26.5 mm diameter.

This has been designed by Central Institute of Agriculture Engineering (ICAR), Shri Guru Tegh Bahadur Complex, TT Nagar, Bhopal-462003



PVC TUBE MAIZE SHELLER



FRONT VIEW

Fig 21. Tabular Maize Sheller

3 6 *Pyrolyser*

Pyrolysis is the physical and chemical decomposition of organic matter accomplished by the application of heat in the absence of oxygen

40-45 kg of agro-wastes, eg. dry leaves and sticks can be fed in the pyrolyser (fig 22) and 20 kg of charcoal, which is a smokeless fuel with good calorific value, can be obtained in a day This is designed by Centre for Development of Rural Technology, Institute of Engineering and Rural Technology, 26 Chatham Lines, Allahabad-211002.

3 7 *Three-Tyne Cultivator*

This implement performs sowing of seeds with fertilisers in rows. Spacing between the rows can be adjusted. The three tynes with steel showel are mounted on a tool bar (Fig.23). It can cover one hectare per day (bullock speed 2.5 km per hour).

It has been designed by Centre for Development of Rural Technology, Institute of Engineering and Rural Technology, 26, Chatham Lines, Allahabad-211002

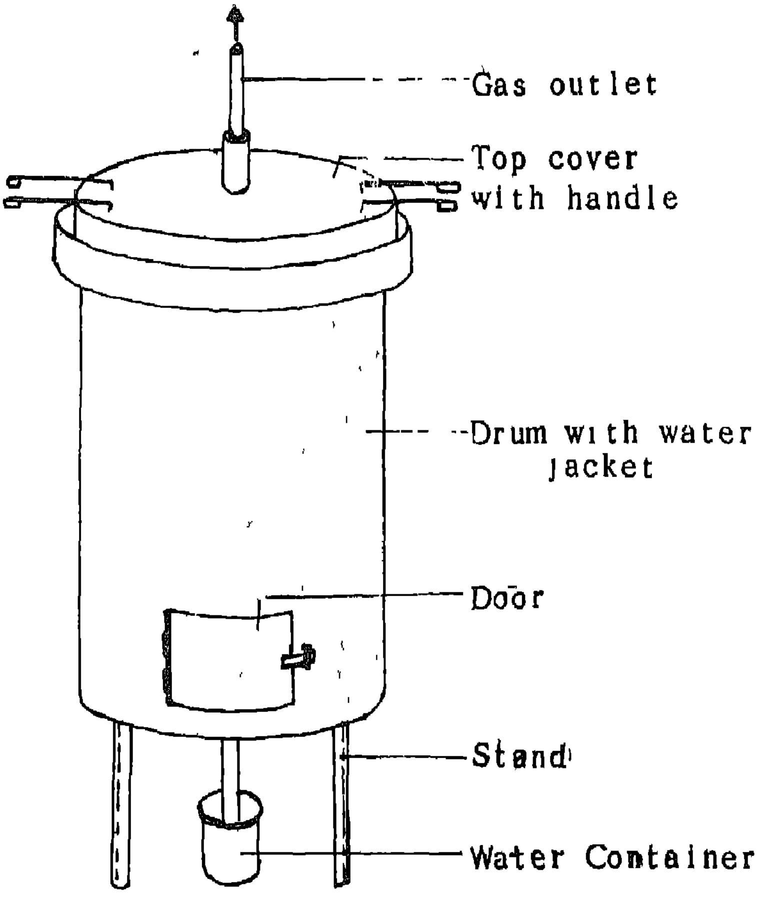


FIG 22 Pyrolyser

3 8 Waste-water Disposal system for Rural Areas

This system has an ash-silt tray chamber and a borehole Waste water from bathing and cooking areas, which threatens to flood dwelling areas and lanes and become breeding ground for mosquitoes and flies, enters the left chamber (Fig 24). After nearly 4 months the ash-silt has to be cleaned. Coarse aggregates collected in the second chamber will need cleaning after nearly 8 months. This has been designed by Central Building Research Institute, Roorkee-247667.

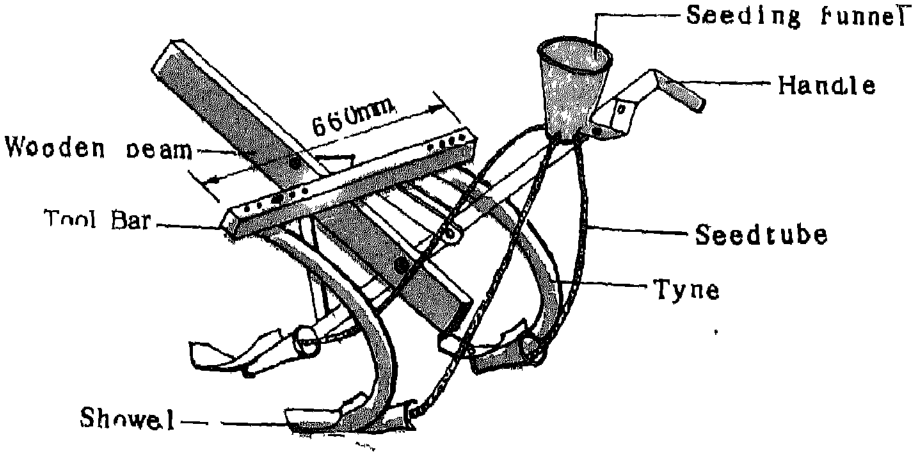
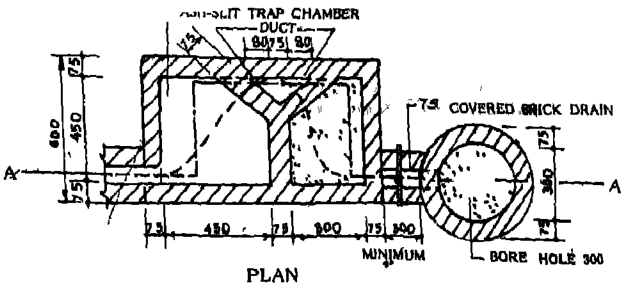
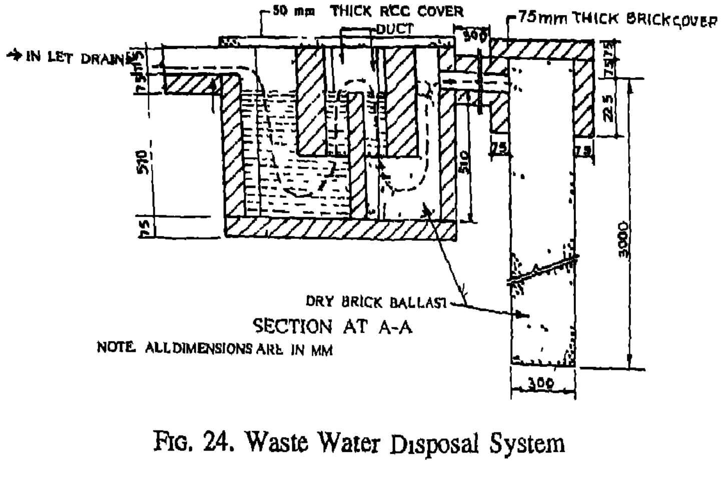


Fig. 23. Three-tyne Cultivator



PLAN



SECTION AT A-A

NOTE. ALL DIMENSIONS ARE IN MM

Fig. 24. Waste Water Disposal System

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II

Creative Activities and Preparation

First section of this chapter has two exercises. While solving these you will be able to discover your own innovative power Basic principles of graphics have been discussed so that you may start working on creative compositions. After reading this chapter you will be able to foresee problems which might crop up during execution of your project; you will be able to classify them and think of solutions in advance

1. Creativity in Simple Problems

The thought processes in designing innovative exhibits for science exhibitions are same as those involved in many important acts of scientific creativity Creative presentation is the cream of any science exhibition that everybody generally looks for There are numerous experimental studies on how an individual produces a novel solution to a problem.

There are four stages in all creative activities. The first stage is **preparation.** This involves a long period of conscious and intense work by a person without any success Subsequently the problem is generally shelved consciously or unconsciously and this is a period of **incubation.** After this the person might experience a sudden **illumination.** This is a flash of insight into the solution of the problem Acually illumination stage usually produces only a glimmer of solution This is followed by the final stage called **verification.** Here the correctness of illumination is verified.

You are given a candle, a match box and a box of tacks You are to attach the candle to the wooden door so that the candle burns properly and you can get enough light for reading without using anything additional to what have been given in Fig. 25 After reading this problem carefully, you are to live with the problem for sometime till you get the pleasure of finding correct solution Then check whether you have gone through the four stages described above

Some problems are called 'insight problems' Their solution requires restructuring of the problem This restructuring is accompanied by the sensation of a flash of insight Many persons are unable to solve such problems as their preconceived notions in the form of assumptions keep them away from the straight-forward solution If such a problem is approached on its own terms, the solution becomes trivially easy

You may verify this fact while solving the dot problem given in Fig 26 All the nine dots are to be connected by four straight lines, without lifting your pencil from the paper Don't consult others before you have solved

Imagination is basically exploring mentally with the help of perceptual images in various possible directions and ramifications and reasoning is crystallising and pinpointing certain elements of the consciousness Grouping, regrouping, organising and reorganising of the data of consciousness are the elements of continuous mental activities Whether he/she is a scientist or an artist, a performer or an explorer, the creative person works relentlessly for perfection Almost the same stages of development are involved in any field of creation

2. Creative Presentation

We need to know basic principles and techniques and should have some experience in the field in which we want to take up creative activities. Sketching and/or painting is one field in which all of us have some experience So let us find out how to prepare presentable graphics so that the visitor in the science exhibition gets the message easily, clearly and quickly. Scope of innovation in graphics is unlimited. As a beginner you should keep the following basic principles in mind and then go on to create superior compositions.

— lay out a plan on a sheet of paper because planning lies behind any worthwhile work

— a good graphic work represents only a single or principal idea

— use choicest words only and let others knows the virtue of economy of words. Use bold but simple letters, fancy lettering is seldom effective

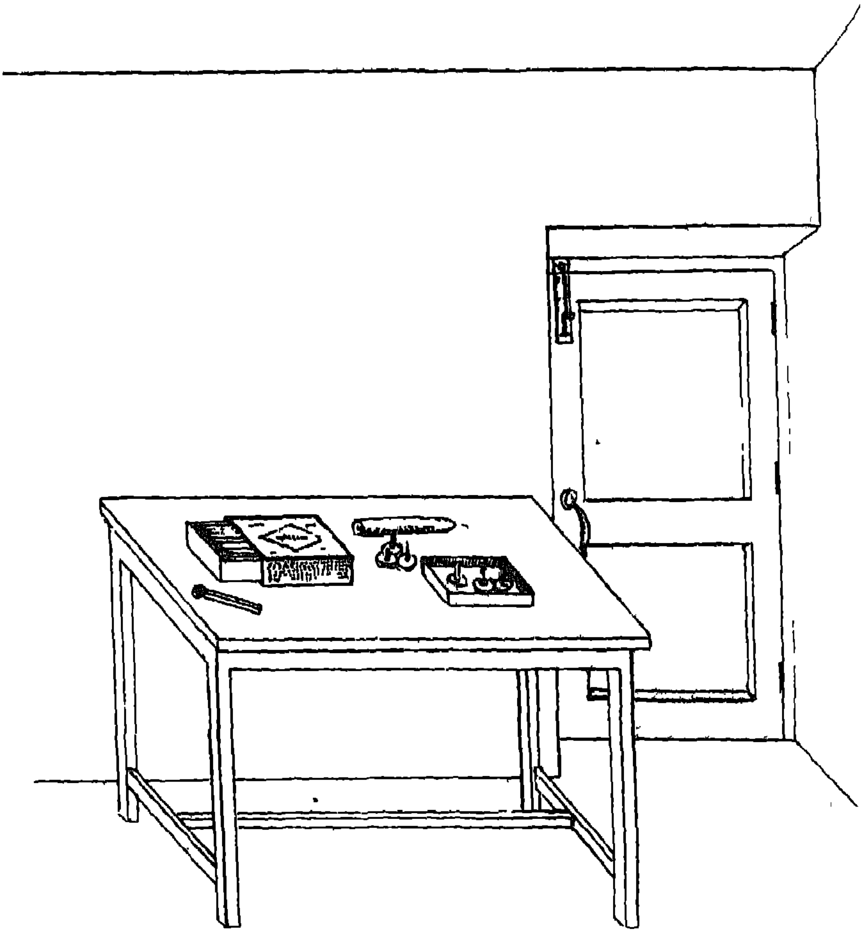

FIG 25. Wooden Door and Candle Problem (Ref 1)

make your graphics interesting and provide lot of space Employ pictures, graphs and illustrations suitable for the purpose

avoid crowding of too many illustrations and unwanted elements

key to the success of a graphic material lies in the fact that it should be concept-wise very clear and simple to interpret

The lay out should make sure that eye of the viewer is led immediately to the main points Opposition or obstruction is to be balanced Secondary details should not be rival to the main points

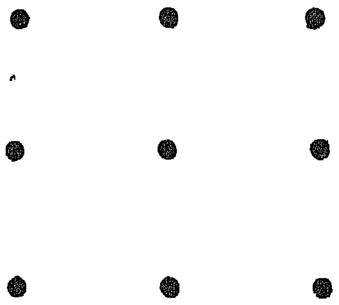

FIG 26. Dot Problem

- you are to first decide the main constituent parts; try distribution of blocks of sketches and lettering on the given space in the forms of L, Z, I, S or T. Select the form that comes out most dynamic and appealing for the given topic and space (Figs 27 to 30)
- make your graphic large enough so that one can read the subject easily at least from a distance of three metres

After drafting the layout you are to plan the colour scheme. Colour is an important element of display as it emphasises the basic points and makes the content distinct It has great carrying power and visual impact

White emerges from the combination of all colours and it reflects all light waves while black absorbs all light waves Black is the consequence of absence of all colours. Figure given on page 134 shows electromagnetic spectrum and visible light. The human eye responds to the wave length range approximately between 3800 and 7600 Angstroms (A°) White light is a mixture of all visible lights. Newton was the first scientist to say that a white light consists of appropriate mixture of seven coloured lights i.e. Violet, Indigo, Blue, Green, Yellow, Orange and Red However, it can be shown that white light is formed by mixing equal amount of Red(R), Green (G) and Blue (B) lights All other colours of light can also be formed by mixing R,G, & B lights in appropriate ratio. Our brain gets sensation of colour when electromagnetic waves of appropriate wave length strikes the retina in our eye Wave lengths of approximately 4000A°, 5000A°, 6500A° correspond to the sensation of Blue, Green and Red respectively in our brain.

If white light passes through a filter (say Blue) the frequency corresponding to Blue will pass through it, other frequencies in white light will be absorbed. As white light strikes an object of a particular colour (say Red), the object will reflect

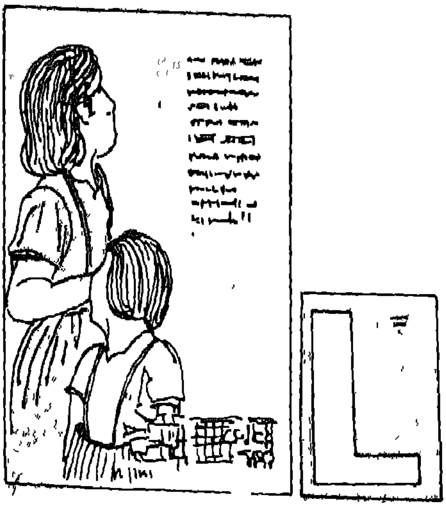

FIG 27

FIG. 28

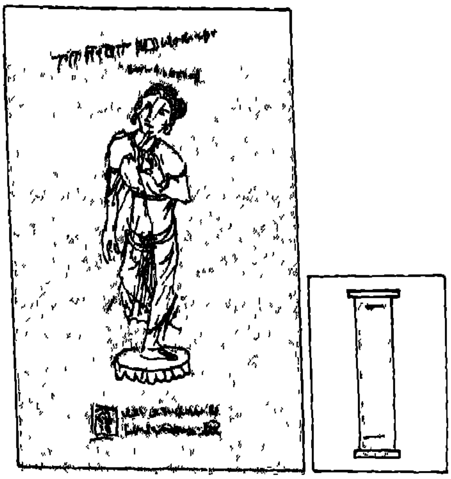

FIG 29

FIG 30

the frequency corresponding to Red light and absorb other colours of white light. If the beam of white light first passes through a filter (say Green) and then falls on a Red object, the object will appear black These are the examples of colour subtraction. On the other hand, if two beams of light pass through different coloured filters and fall on a white object, the object, reflects combined frequencies of the two beams This is the case of colour addition Red, Green, Blue are called additive primaries, because addition of R, G, B coloured lights produces white light. In painting, photography, printing etc. where we use coloured pigments, the colour mixing follows the subtractive principle which could be explained as follows.

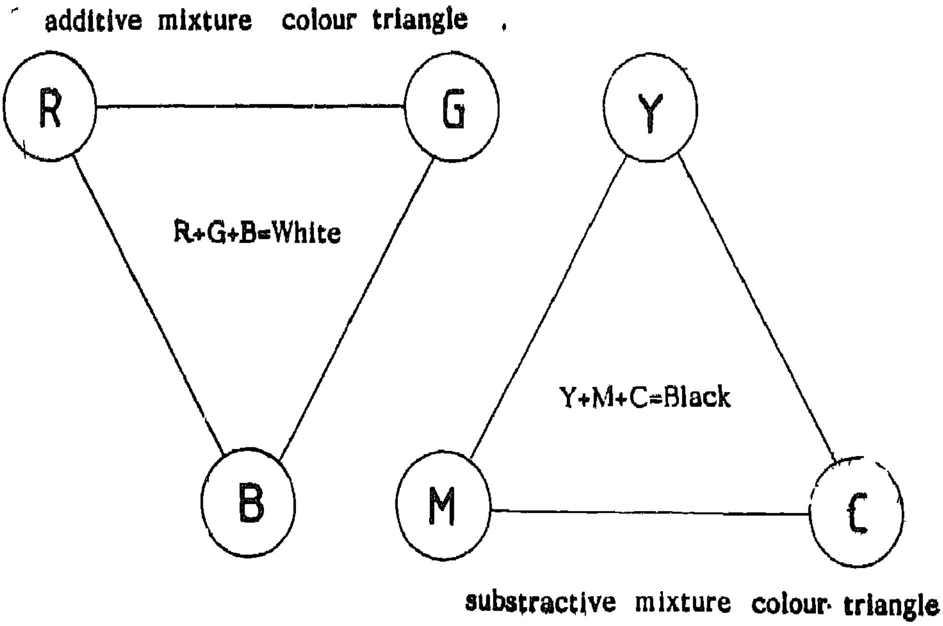
additive mixture colour triangle
R
G
B
R+G+B=White
Y
M
C
Y+M+C=Black
substractive mixture colour triangle

Fig 31. Colour Triangles

A surface looks white if equal amount of R,B,G lights reflected from it enter our eyes A surface that reflects R & G lights but absorbs B light will look Yellow to us because an equal mixture of R&G appears as yellow to the eye In the same way a surface that absorbs R and reflects G&B will appear as a colour called Cyan; and a surface that absorbs G and reflects R & B is called Magenta coloured surface. For substractive colour we use Yellow, Cyan and Magenta as three primary pigment colours.

Look at Fig 31 which shows additive mixture colour triangle and subtractive mixture colour triangle The colours which are opposite to each other in the triangles are complimentary ones; for exampleB is complimentary to Y

Let us see which colour emerges when we combine Magenta and Cyan pigments

Colour	*will reflect*	*will absorb*
Magenta	R & B	G
Cyan	G & B	R

So only B will not be absorbed; the resulting colour will be blue.

Can you predict the colour of the mixture of pigments in each of the following cases:

(i) Yellow + Magenta
(ii) Yellow + Cyan
(iii) Yellow + Red
(iv) Blue + Yellow
(v) Green + Blue

Monochromatic harmony is made up of dots and shades of any single colour. *Analogous harmony* consists of colours which are neighbours on the colour chart; eg. a composition having yellow, yellow-green and green. *Complimentary harmony* consists of colours which are opposite in the colour triangles.

Blue, Green and Violet tend to go away from the viewer; so they give the effect of distance. They are called *cool colours*. Conversely Red, Orange and Yellow tend to advance towards the viewer; they are usually called *warm colours*. As a general principle in graphics, backgrounds are subdued and important details contrast strongly with them.

N.B. Newton called colours red, orange, yellow, green, blue, indigo and violet. Nowadays Newton's 'blue' is called 'cyan' and the combination of his 'indigo' and 'violet' is called 'blue' by colour scientists. 'Magenta' is now the scientific name for 'purple' (Ref. 5).

3. Journey through Forty Problems

T
M

From the moment of your accepting the assignment to the final stage of returning home after presenting your creation in the science exhibition, you will face dozens of problems. Forty problems have been foreseen here taking account of the worst situation. You should create solutions in your mind during preparation.

(I) Student's initial problems after he/she is given the theme and asked to prepare exhibits

(1) Nothing is left for me to invent
(2) I am not the right person to do it.
(3) No knowledge how to go about
(4) I don't want to expose my weakness to my teacher and fellow students.
(5) When I want to make something novel, I find my imagination very ambitious and unrealistic
(6) My teacher does not have enough time to guide me.
(7) I have never handled even a screw driver

(II) Problems of execution

(8) I have no conception of correct materials and source of availability though I have got an idea by now.
(9) No funds for tools or materials.
(10) No working place, no tools.
(11) No knowledge of handling tools and making things.
(12) My first attempt consumed many hours and yielded a horrible looking object which does not work.
(13) First attempt has also left the nail of my left thumb smashed.
(14) Even if the model works, its performance is unstable.

(III) Problems of transportation

(15) The working model is too big / heavy to transport
(16) It is too delicate to carry.
(17) It is too brittle to carry.
(18) Its construction does not allow easy packing
(19) It runs on kerosene which can't be transported.
(20) I also need acid which can't be transported.
(21) It is difficult to reassemble the parts at the exhibition site.

(IV) Problems during display

(22) The working model has gone out of order on the very first day.

(23) My voice is lost temporarily on the first day as I have to speak continuously for 6 hours.

(24) I have fallen sick due to dust and new climate.

(25) Visitors take long time to understand.

(26) I get chorous of simultaneous questions from dozens of visitors.

(27) Visitors try to come very close to read the captions, diagrams etc. and disturb the set up.

(V) Problems in the exhibition pavilion

(28) Electric wiring is loose and dangerous.

(29) Defective lighting (direct glare to the visitors).

(30) The sound of PA system is very high and disturbing.

(31) The experiment on explosion being done every 5 minutes by my neighbours gives out loud bang and smell of gunpowder.

(32) I have to compromise safety by carrying on hurried repairs of dangerous parts or live wires to oblige the crowd.

(33) Exhibition is affected by sudden rain/storm.

(34) Drinking water is in short supply.

(35) Power failure is very frequent.

(36) The exhibit has been damaged due to morning dew, dust etc.

(VI) Post display problems

(37) Dismantling is difficult.

(38) Packing boxes and materials are missing.

(39) Help from friends are not available as everybody is in a hurry to pack up.

(40) After returning to the school, no enthusiasm is left to unpack and display the exhibit for the benefit of others.

You may like to add a few more problems under one or more headings. Each problem has a solution which is not beyond the striking distance. If there is no specific solution, you are to find out alternatives to achieve your target. Corresponding preparations in advance for overcoming these problems are suggested in Appendix-II Read them only after you have thought out the solutions yourself.

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III

Project Technology and Workshop Practice in Schools

Fabrication of Science Models, Equipment etc.

Learning Objectives

This chapter guides you to do hands-on activities so that you can get the pleasure of giving shape to your idea on the work table. After going through this chapter you will be able to

- *identify a work-place in your institution, set up work tables and arrange minimum working facility under the guidance of your teacher. Among others you will be able to make provision for first aid etc*
- *work with hand tools and measuring tools. Exercises given here have been designed to prepare you for difficult assignments.*
- *work on wood, metal, glass, plastics etc*
- *give final finish to your model by painting*
- *work with wax, papier mâché, plaster, polyester resin, plastic film etc so that you may prepare atomic models, replicas for biological studies and scale models of many objects of interest*
- *know about engines, radio controlled kits, ship models, gliders etc if you want to work in the area of aero and ship modelling*

1. Working Facilities, Safety Precautions and First-aid

1.1 Working Facilities

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(a) Work table A general purpose work bench will be easy to fabricate locally and can be used for science club activities in schools The work bench is usually 3 to 3 65 m, 0 71 m wide and 0 71 m high While this size is suitable for four students to work, a size of 3 75 to 4 3 m x 1 20 m x 0 71 m is suitable for six students The height of the table may be worked out from the proportions of Standing Height (SH) of an average student, as given below

Working surface	*Ratio*
General height of work surface	0.52 SH
for ironing/planing	0.50 SH
for cooking	0.48 SH
for filing metal	0.56 SH

The bench should not rock while heavy work is carried on it. The top of the work table is generally made of thick planks of wood or nova board. Depending upon the availability of space, tool racks may be arranged on the bench itself for keeping tools in proper place so that they do not crowd on the work bench.

Where electricity is available, the work table may be provided with one 15 amp. electric socket, for power and three 5 amp. sockets for different applications. Alternatively one extension board with appropriate length and diameter of lead wires may be provided.

(b) Tool Storage: storage of tools should be arranged so that one can get them easily without the possibility of knocking others over. Each tool should have its place on the shelf or in the chest and should be within easy reach. It is to be kept in mind that tools become unserviceable through rust and wear. Proper storage in a dry place with application of rust inhibiting paper coated with oil or lacquer is desirable Linseed oil is most suitable for such purposes, it can be applied with a wad of cotton wool. The wearing of tool is mainly due to lack of lubrication during work. They do not need much oil but they do need the right kind at the right place.

Most suitable ways of storing tools in schools and training institutes are suggested as follows:

TOOL CHEST

Each unit of a size 60 cm × 40 cm × 30 cm will be suitable. Inside area of such a chest for tools can be designed according to the number and size of individual tools.

PERFORATED BOARD

Perforated boards fitted on battons secured to a wall near the working table can be used for storing tools. It is not only economical but is also easily accessible and can accommodate many hand tools.

BATTONS FITTED ON WALL

12 mm x 25 mm horizontal strips of hard wood may be fixed on two or more vertical battons by nailing or screwing, leaving a space of 12 mm between them. Tools can be hung by strips, nails or wire hooks.

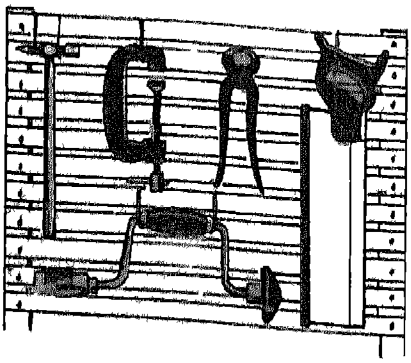

FIG 32. Perforated Board

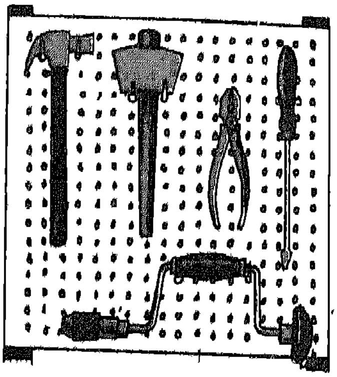

FIG. 33. Battons fitted on wall

TOOL KITS

Sets of hand tools in different combinations are available in the market. They are either packed in sheet metal boxes or wrapped in polyfab/cotton bags. Science Club Kit and Mini Tool Kit of NCERT design are packed in portable sheet metal containers (see Appendices III and IV). Such kits acquired by the schools can be suitably placed on rack so that they are easily accessible to students at work.

(c) Lighting: The daylight illumination level on the work bench should be in the order of 200 to 300 lumens per sq. m. Ceiling and walls should have satisfactory standard of reflectance so as to obtain the desired brightness level on the work bench. Glares to the eyes of the workman should be eliminated. Many science club activities require direct sunlight. Provision of getting direct sunlight even for a short period may be kept in mind while designing the working space.

1.2 Safety Precautions and First Aid

SAFETY PRECAUTIONS

No flame should be allowed in the room where inflammable chemicals and gases (LPG, petrol, spirit, kerosene etc.) are kept.

While diluting, acids are always poured into water.

Resins and catalysts are inflammable and their fumes may cause health hazards.

Burning plastics give dangerous fumes. So proper ventilation is necessary while working on those.

Solar reflector or lens for concentrating sun rays, if not carefully handled and set right, may cause fire and may injure the eyes of the visitor or the operator.

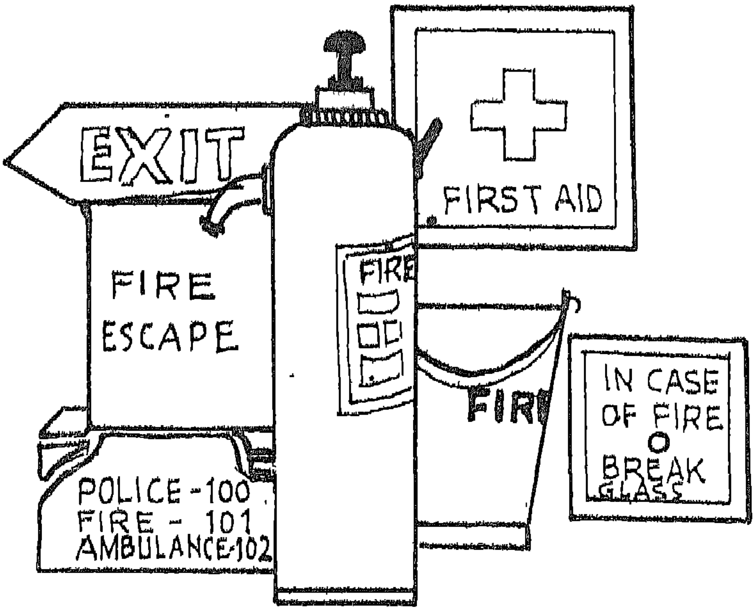

FIG. 34.

Don't wear rings, watches etc. which could be caught in machinery.
Always stop a machine before measuring, cleaning, oiling or making any adjustment.
Never operate a machine unless all safety guards are in place.
Don't try to stop any moving part of a machine with your hands.
Always keep the floor free from oil, grease, tools and metal cuittings.
Never talk to anyone standing nearby, while operating grinders, drilling machine or any machine which produces flying metallic cuttings.
Work on a machine only when you are physically fit.
Don't try to remove foreign bodies from your eye. See your immediate supervisor at once for advice and help.
Don't carry a sharp tool in your pocket.
One must wear goggles while working near furnaces and ovens, acids etc.
Never touch the material when you are welding as there is high amperage current which is dangerous.
While using hammer and chisel, make sure that these are not greasy or the face has not been battered and broken up.
Never hold work in your hand while tightening or loosening with a screw driver.
Be sure that screw driver fits the slot on the screw head.

A screw driver is meant to turn screw, not to use it as chisel or to level off the lid of a packing case.

Never use a file, without a handle. It may slip and allow the tang to puncture your hand or arm.

Don't blow filings where they can fly into your own or someone's eyes.

Never store tools one over the other, since the tools get blunt or spoiled.

While operating the buffing wheels, always use goggles.

While drilling a hole in metal, make an impression with a centre punch so that drill may not slip.

Gloves should be worn while handling sheet steel, or any other sharp material.

While doing electrical repairs involving live connections, be sure that electricity is off.

Never keep heated soldering unattended in the open.

When soldering the surface must be cleaned first for any oily element and proper solder with paste should be used.

Don't force a saw, if it cuts slowly. Get it sharpened from a professional sharpner.

If a piece of wood has nails in it, never use a plane as the blade of plane will get blunt.

Always keep your tools sharp, even if these are rarely used.

Make a case for your oil stone as soon as you buy it and never use it dry.

Don't temper with electrical devices or electrical equipment.

While working with capacitor keep in mind that capacitor can store enough energy for a lethal discharge.

Never touch even one bare wire of an electrical circuit before switching it off.

In the case of electrocution, remove the victim from the electrical circuit without endangering your own safety and begin artificial respiration at once; the victim must be immediately attended by a doctor.

In case of accidents like shock, strains, ruptured muscle, bruises, wounds, burns, fractures, etc, always give casuality first aid, call the doctor or remove him/her to the hospital at the earliest.

First Aid

First aid is the immediate help and assistance given to an injured or sick person until the services of a physician can be obtained. The value of first aid is being recognised more and more and a knowledge of this subject is of immense benefit to everyone. According to some experts there are nine golden rules of first aid.

1. Do first things first quickly and without fuss and panic.
2. Give artificial respiration if breathing has stopped— every second counts.
3. Stop any bleeding
4. Guard against shock by keeping the casuality warm; move him/her as little

as possible by gentle handling.

5. Don't attempt too much; do the minimum that is essential to save life and stop further aggravation.
6. Reassure the patient and those around; help to lessen anxiety.
7. Don't allow people to crowd around as fresh air is essential
8. Don't remove clothes unncessarilly, as they help to keep the casuality warm and so protect against shock.
9. Arrange for removal of the casualty to the care of a doctor or a hospital as soon as possible.

In case of acid burns, wet the spot first with drinking water and then with weak solution of ammonium hydroxide or sodium bicarbonate or borax (10% solution). Then apply vaseline and cover the spot.

In case of alkali burn, do same as above but use a solution of acetic acid or lemon juice in place of alkali solution.

A standard first-aid box can be bought and placed near the work table in such a manner that it is accessible to anybody anytime. If such a box is not available in the local market, a standard package may be bought as per prescription of a doctor. Generally a first-aid box contains the following items:

(1) A small packet of white lint
(2) A small packet of pink boracic lint
(3) One packet of obsorbant cotton wool
(4) Bandages—at least two, each of two and three inch width
(5) A few safety pins
(6) Non-poisonous disinfectant i e. Dettol
(7) 50 c c of weak solution of iodine
(8) Adhesive plaster or dressing strip
(9) Cold cream
(10) Antiseptic ointment
(11) A clinical thermometer
(12) Methylated spirit
(13) A pair of surgical scissors
(14) Suitable general purpose solution for eyes
(15) Burnol

2. Tools for Fitting, Sheet Metal Carpentry, Plastics, glass work

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The following tools and materials are minimum essential for workshop practice in secondary/senior secondary schools/science clubs. 5 to 10 students can work with these tools at a time (all of them not on the same job) If more students are to work, proportionate number of tools will be required.

The school may also procure additionally Mini Tool Kit (NCERT), Science Club Kit (NCERT) or any other standard pack of tools. The packing lists of Mini Tool Kit and Science Club Kit (NCERT) are given in Appendices III and IV.

2.1. *List of Handtools*

Fitting, sheet metal, carpentry, plastics, glass

1. Electric drilling machine with drill stand-1
2. Fretsaw (Foot operated)-1
3. Bench lever shear - 1
4. Plastic injection moulding machine (hand operated) 30 g-1
5. Bench vice, 120mm - 2
6. Wood working vice - 2
7. Hammer, ball pein, 200 g - 5
8. Claw hammer - 200 g - 2
9. Screw driver, 2.5 x 60mm - 10
10. Screw driver set with common handle - 5
11. Chubby screw driver - 5
12. Instrument maker screw driver set - 5
13. Side cutting pliers - 100mm - 5
14. Flexible magnifier - 1
15. Shear snips, 200mm - 5
16. Adjustable wrench medium - 2
17. Twist drill set from 0.8mm to 6mm - 2 sets
18. Hand drilling machine - 5
19. Files - rasp, flat, half round, triangular, round-medium - 5 each
20. Scissors, 150mm - 5
21. Hacksaw, 250mm with spare blades - 5
22. Reamer, tap and die sets with handle - 1 each
23. Carpentry saw, tennon saw, 300mm - 2 each
24. Junior Hacksaw with spare blades - 5
25. Chisels - firmer (19mm), bevelled (12mm) mortise (6mm) - 1 each
26. Plane, 225mm - 1
27. C-clamp - 5
28. Ruler 30cm, stainless, graduated in inch and mm - 10
29. Vernier caliper, 0-150mm - 1
30. Micrometer 0-25mm - 1
31. Combination set - 1
32. Wire gauge - 1
33. Dial indicator - 1

34. Surface plate - 1
35. Spirit level, ordinary - 1
36. Ordinary caliper, inside and outside—5 each
37. Try-square - 5
38. Scriber - 5
39. Surface Gauge - 1
40. Divider - 5
41. Marking gauge (for wood work) -2
42. Punch - 5
43. Ratchet brace with different bits - 1 set
44. Diamond glass cutter - 1
45. Brush, 50mm - 5

Consumables

Wood screws, machine screws, nuts, nails, sand paper, emery paper, grease, oil, stone for grinding, cellotape, adhesive and sealants, synthetic glue for wooden joints (Fevicol, movicol etc) paint, varnish etc.

2 2 *Metal and Wood Working Hand Tools*

The beginner has to acquire skill in operations like sawing, planing, filing, chipping, polishing, tapping etc. through practice and patience Important common tools are described here with instructions how to use them The beginner should first identify the tools, read the description carefully and then work with them

(a) *Vice* A vice is used to hold a work in the desired position firmly between its jaws. Operations like filing, planing, cutting, etc. are done on the work in this position There are varieties of sizes and shapes of vices A vice has a fixed jaw, a movable jaw and a threaded rod Certain type of vice has swivel base to facilitate fixing at any desired angle in the horizontal plane To hold finished or soft metal, the jaws are covered with jaw caps made of sheets of copper, brass or aluminium Some types of vices are given below.

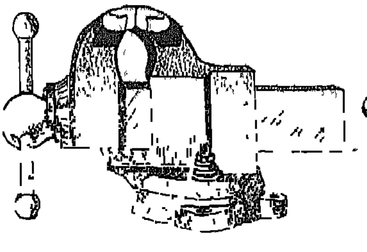


FIG 35(a) Bench vice

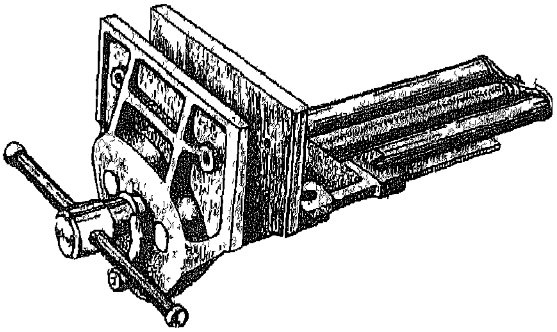


FIG 35(b) Wood worker's vice

BENCH VICE

It is also called engineer's parallel jaw vice and is commonly used for metal work. The jaw width is generally between 62 and 200mm and opening capacity between 62 and 230mm.

WOOD WORKER'S VICE

The jaw width varies from 150 to 262mm and the opening capacity from 112 to 375mm. A large vice is fitted with a quick release system (enables jaws to move quickly). Jaws are generally lined with hard wood of 18mm thickness so as to protect the work as well as the jaws.

PIPE VICE

It is used for holding pipes and round bars and is very commonly used in plumbing work. It strongly grips the round at four points during operations.

PIN VICE

It can hold small parts during intricate operations. It is generally used by watch makers and goldsmiths.

HAND VICE

It is generally used by tool makers for holding small objects like wire and small pieces of sheet metal during drilling. It is also used for making keys for locks,

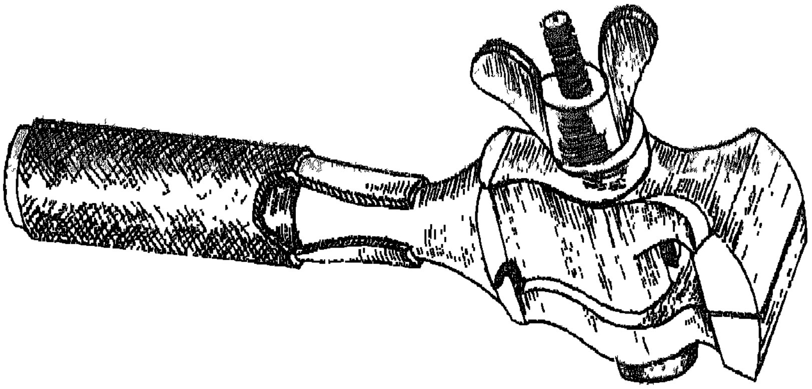


FIG. 36. Hand vice

Leg Vice

Its body is made of forged steel which can withstand blows of smithy hammer and is generally used on black smith shop floor.

(b) Hammer: The size of the hammer depends upon the nature of work i.e. light duty or heavy duty. The type of hammer is determined by the nature of operation. The hammer to be used in the fitting and sheet metal may be one of ball pein, straight pein or cross pein type. These are available from 112g(4 oz) to 784g(28 oz). The smaller sizes are used for lay out work and larger ones for different types of bench work. A soft metallic sheet need be hammered with a wooden or plastic head so that it is not damaged. In carpentry work a claw hammer is generally used. The claw end is used to pull out nails. Smithy work demands heavy duty hammers which generally employ handles made of good quality bamboo.

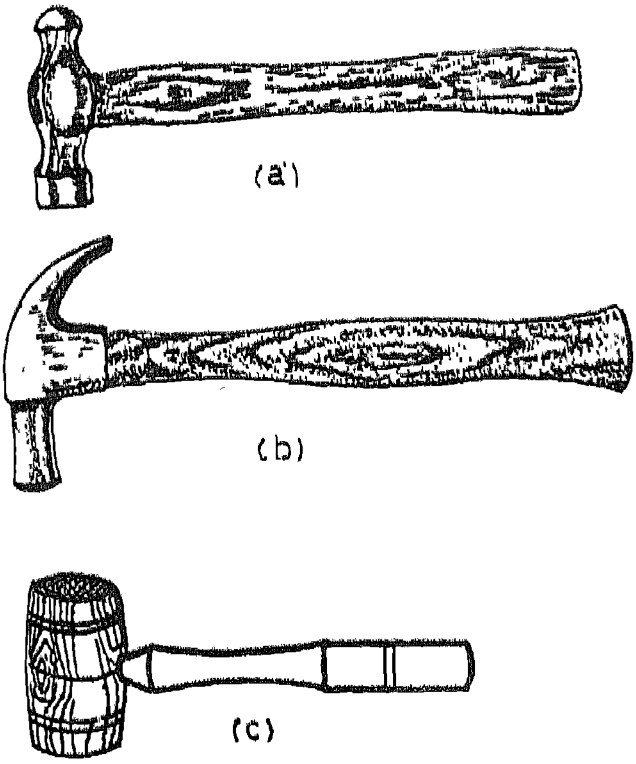


Fig. 37. Hammers (a) ball pein hammer, (b) claw hammer (c) mallet

(c) Screw Driver: It is available in many sizes to fit a wide variety of screws. It

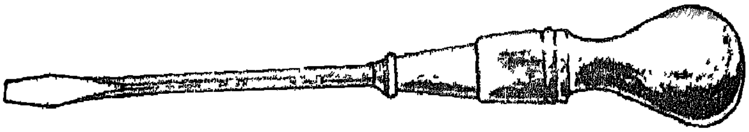


FIG. 38 Screw Driver

is available in various lengths up to nearly 300mm A screw driver set contai sizes of screw drivers. A screw driver should never be used as a chisel.

(d) Shear Snip. This is used for cutting thin sheets of metal, plastic, fibre etc. I has short blades and long handle which give the needed leverage for cutting. The sheets can be cut by holding the snip in hand. Thicker sheets are cut by holdin one leg of snip in vice and pressing the other under the palm There are many kind of snips i.e Hawk's bill, circular snip, universal snip, double cutting snip, aviatio snip etc.

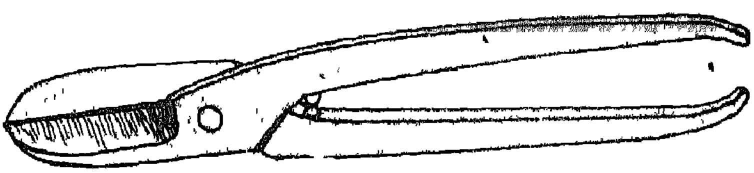


FIG 39 Shear Snip

(e) Chisel The cold chisel is made from hexagonal steel bar of 300 to 450 m length, bit width 6 to 25 mm, this is used for cutting metal in cold condition. H chisel which cuts metal in hot condition has smaller wedge angle. The metal generally held in a vice and the chisel is driven in it by hammer blows.

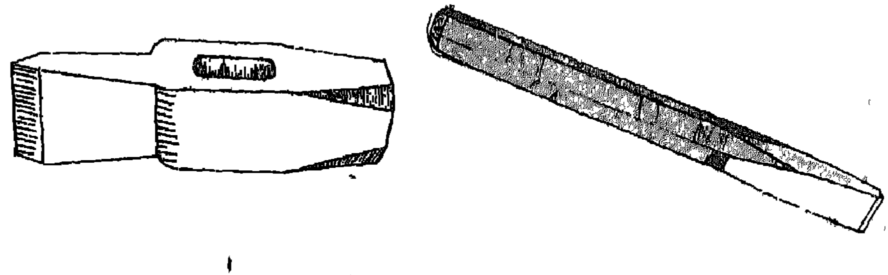


FIG. 40 Chisel (a) cold chisel (b) hot chisel

(f) Hacksaw: The hacksaw is used for cutting metals. It has a handle, U-frame, wingnut and spigot which is fitted to a flexible steel blade. Usually a blade is 12 mm wide, 0.6 mm thick and 250 to 300 mm long. Steel blades may be completely hardened or semi-hardened. The former is suitable for mild steel and cast iron while the latter is used for sawing copper, brass, aluminium. The number of teeth on blade varies from 14 to 32 T.P.I. teeth per inch). The teeth of hacksaw should always be pointed away from the handle.

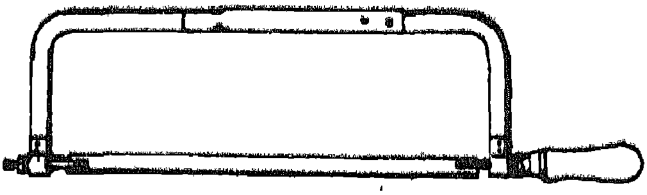


FIG. 41. Hacksaw

(g) File. It is made of high carbon steel; it is hardened and tempered. It has many

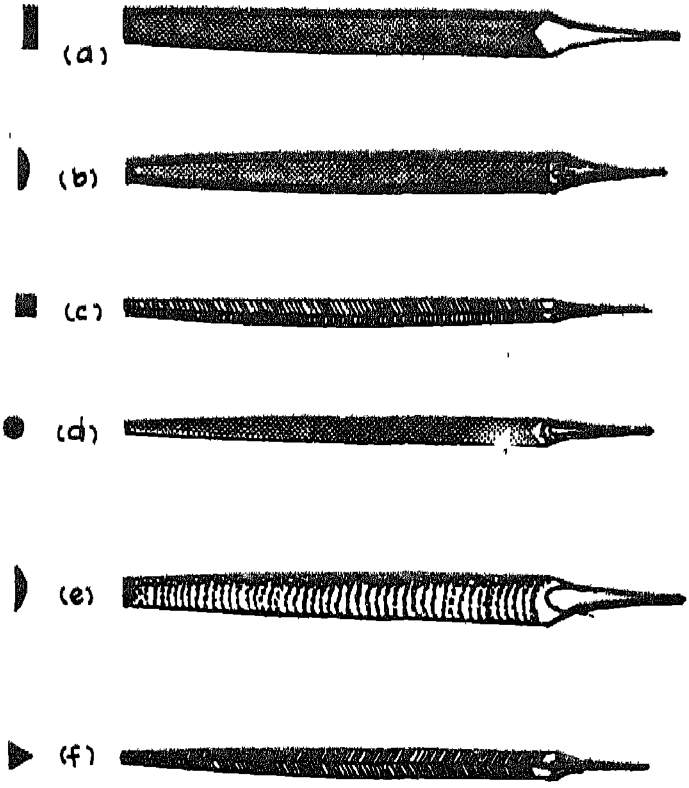


FIG. 42. Files (a) flat, (b) half round, (c) square, (d) round, (e) rasp, (f) triangular

teeth to remove surplus metal to produce smooth surface. There are singl row and double rows of teeth on the file body. Cross cut files remove metal very quickly and provide for easy cleaning of chips. Files have different shapes and sizes. Their cross sections may be rectangle, square, triangle, round, and half round. Knife file and needle file are used on tiny and precision jobs. A rasp with a very rough surface is used in carpentry work.

(h) Hand drilling machine: In a hand drill, the drill bit held in the jaws is rotated manually through gearing. Alloy steel twist drill bit drills hole on almost all metals. Such drill bits are available in various sizes starting from 0.4 mm to 50 mm. The

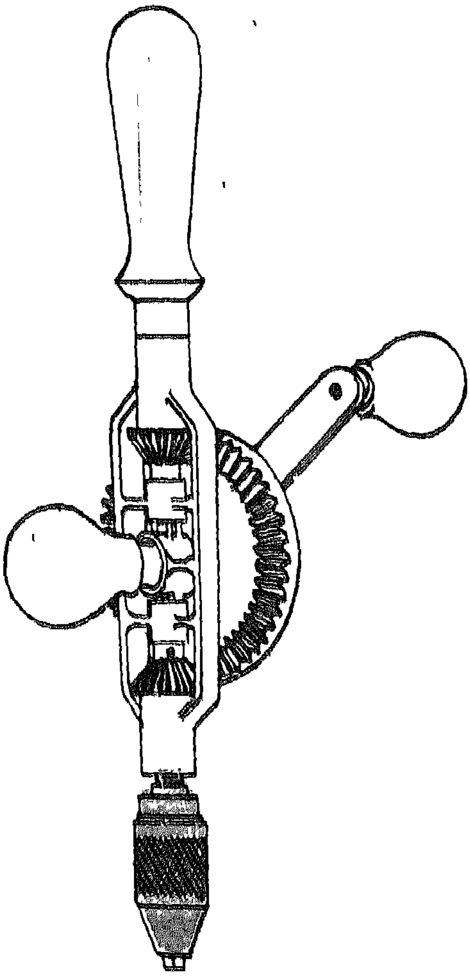


FIG. 43. Hand drilling machine

hand drill generally holds bits upto 6 mm dia For drilling hole on wood, plastic and other soft materials, an iron nail with flattened and sharpened end works as a drill bit

(i) Taps and Dies · Taps cut internal threads in drilled holes while dies cut external threads on a round rod. These tools are made of high quality tool steel. They are used alongwith handles so as to get leverage while threading Each set has three taps for progressive threading.

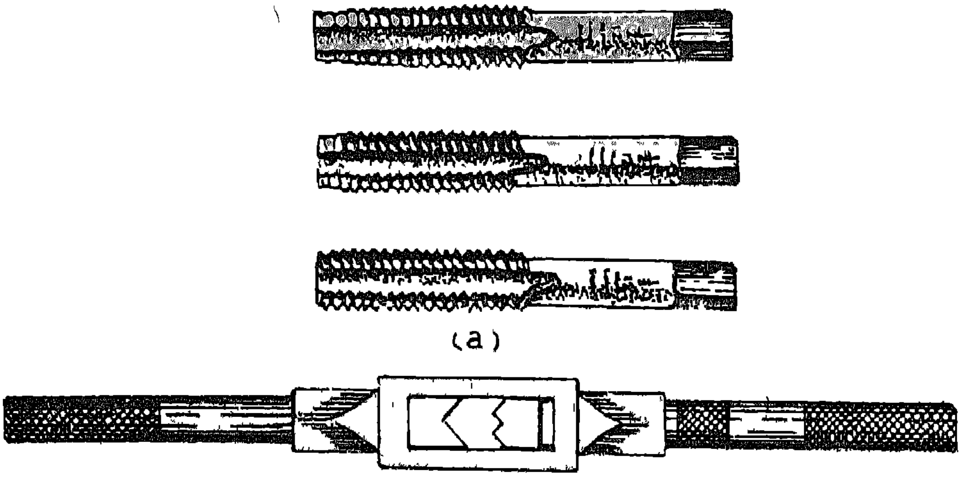


Fig. 44 (a) Taps, (b) Die

(j) Reamer · A hole drilled even by a very accurate drilling machine with all care might not have smooth surface nor precision For making the surface of the hole smoother, a reamer is used subsequent to drilling.

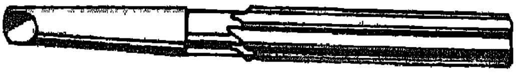


Fig 45 Reamer

(k) Bench lever shear: It is a giant shear snip which can cut thicker sheets through at least 300 mm in one stroke. It has two jaws. Long handle attached to the upper jaw gives leverage.

(l) Carpentry saw, The size of saw is determined by the length of its blade Coarseness or fineness of saw is designated by number of teeth per inch A coarse

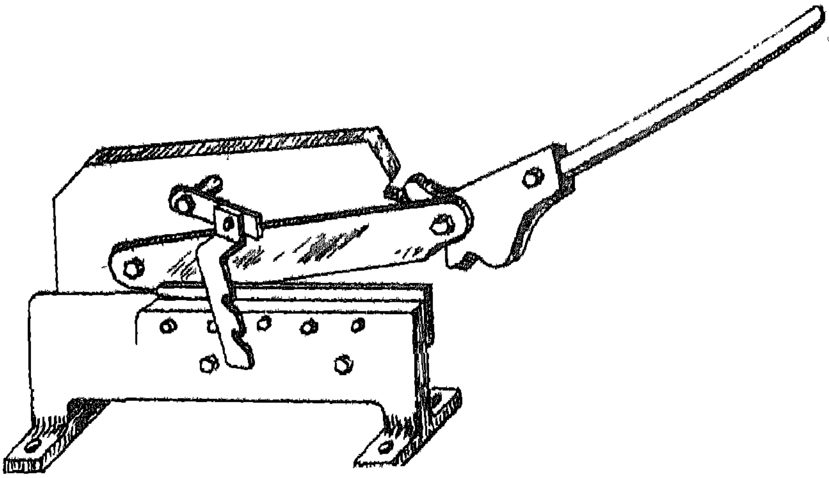


FIG. 46 Bench lever shear

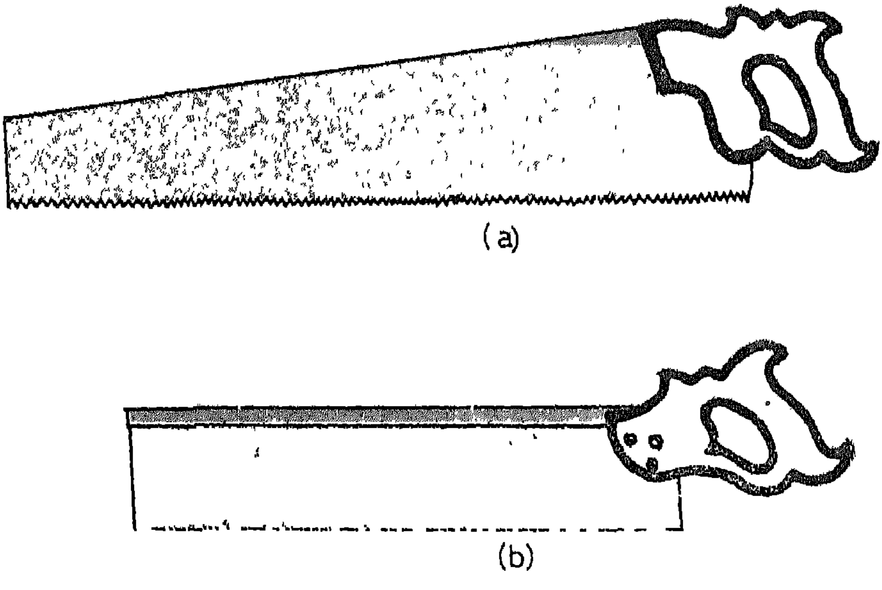


FIG. 47 (a) Carpentary saw (b) Tennon saw

saw is better for rough work while a fine saw is suitable for smoother and accurate work. The teeth of saw are (to be "set" by the workman) bent alternately to left and right.

The most commonly used saws in carpentry work are — rip saw, cross cut saw, dovetail saw, compass saw, key hole saw, etc. A band saw machine is used for slitting timbers. It has an endless saw blade in the form of a belt. A giant saw is handled by two persons holding handles at its either ends while slitting timber manually.

(m) Plane (for wood working): Planing is a very important operation in carpentry work. It makes the surface true and smooth. The body of plane is made of wood or metal. The finish of the surface and efficient-working of a plane much depend.

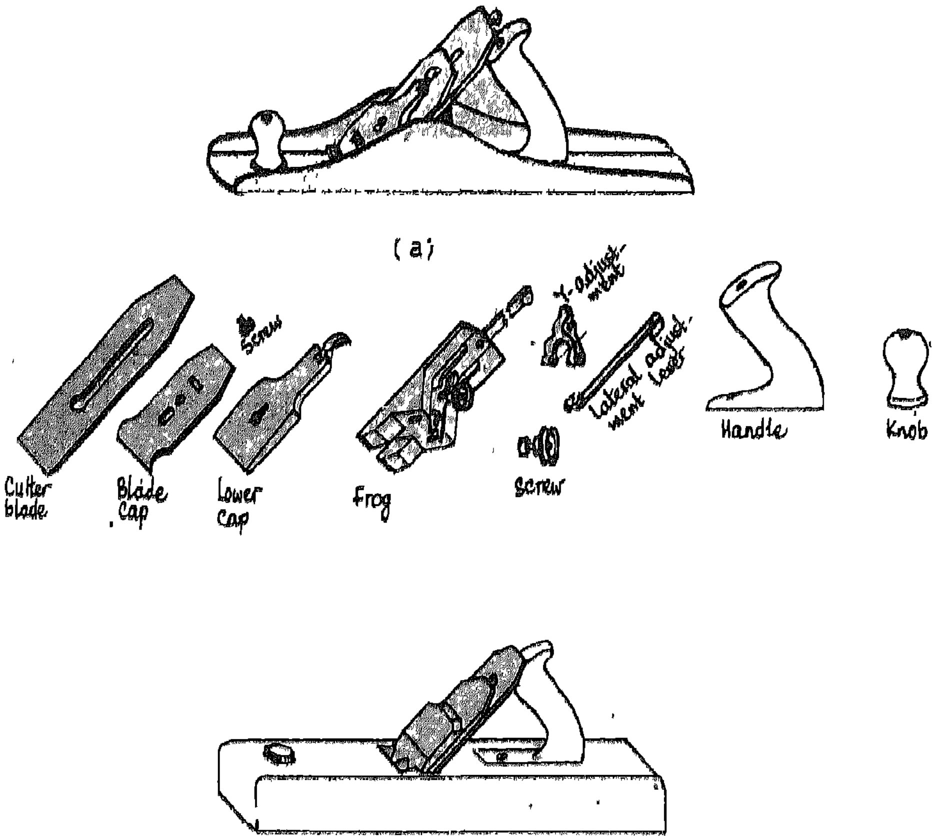


Fig. 48 (a) Jack plane with parts (b) Smoothing plane on the adjustment of the cutting blade Most commonly used planes are jack plane, smoothing plane, block plane, etc. A smoothing plane, 150 mm to 200 mm long will be suitable for average work in a school workshop. Jack plane is bigger in size,

(n) Boring and drilling tools (wood working): Holes are bored or drilled in wood prior to fitting screws, bolts, dowels etc. Tools which can bore or drill without the help of any machine are auger, gimlet, taper, reamer etc. These have a handle which could be held in hand so as to rotate the bit into the work material of wood or plastic. Tool bits like centre bit, auger bit, counter sunk bit, dowel bit, broad point bit, drill and counter sunk bit, drill and counter bore bit, glass drill, twist drill, etc, can be held in any one of brace, corner brace, hand drill or breast drill. Some of these tools can also be held in an electric drilling machine.

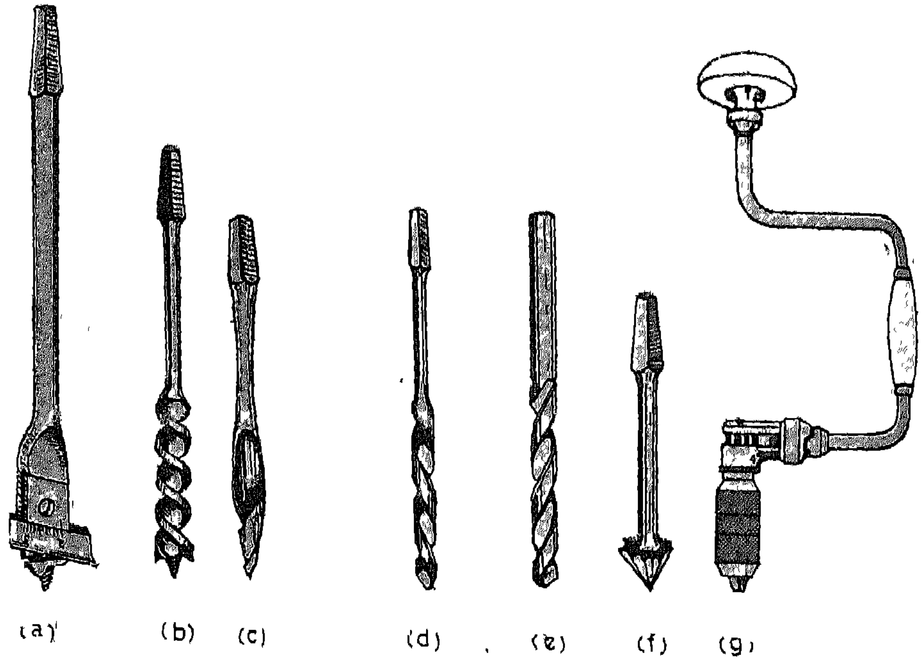


FIG [illegible] (a)-(f) drilling and boring tools
(g) brace to hold drilling or boring tool

(o) Wood working chisels and gouges · A chisel is used to trim and chop wood. The blade of a chisel has parallel sides and tapers slightly from handle to the cutting edge Chisels and gouges are fitted with wooden or plastic handles The most common one is the firmer chisel. Its blade is nearly 100 mm long and width ranges from 3mm to 18mm Other types are firmer, paring, mortise, carving chisel etc

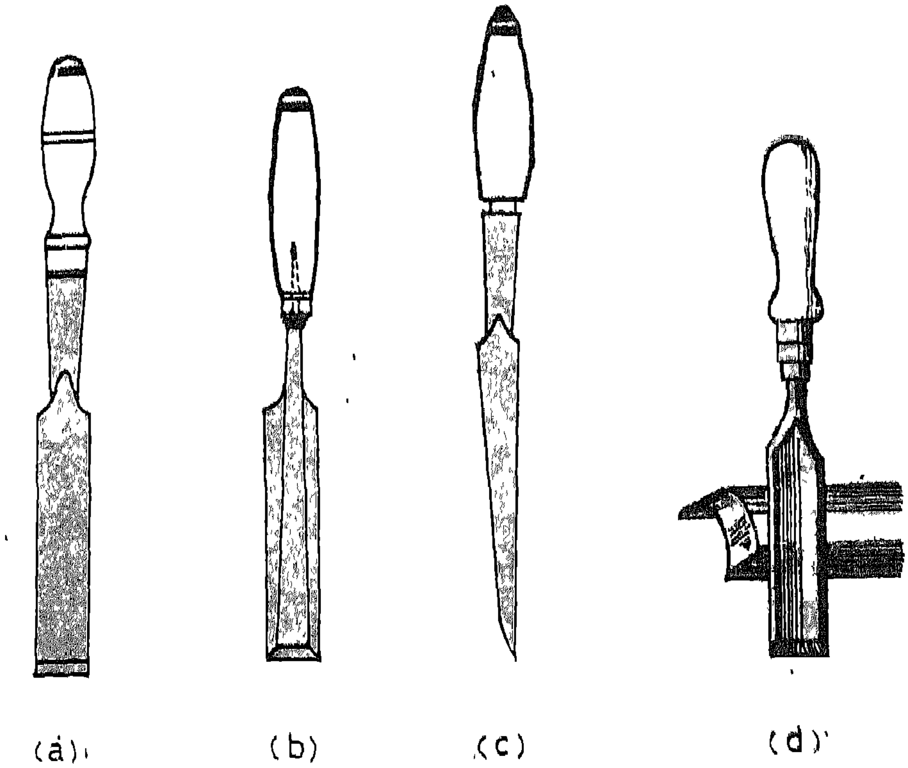


FIG. 50. Chisels and gouges (a) firmer (b) dovetail (c) mortise (d) gouge

(p) Clamps: A clamp is used to hold one surface against another in the desired position with pressures given by screwing in of a threaded rod. The sizes vary from 15 cm to 1.5 m C-clamp is generally used while applying pressure to the parts being joined by glue.

(q) Saw set: The saw set is used to bend the teeth of a carpentry saw to correct angle so as to produce required cut during sawing operation. It consists of handle, plunger, anvil and locking screw. When handles are pressed together, the plunger pushes the tooth against the anvil which is a wheel with graduations on the face

(r) Fretsaw: Fretsaw is very useful in cutting profiles on thin sheets of plywood, hardwood or plastics The thin blade can negotiate any curve. It is foot-operated The sheet is slit by a reciprocating steel saw blade which has sharp teeth of fine pitch

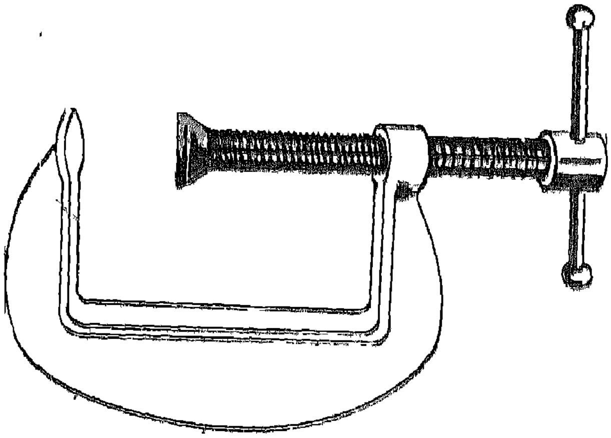


Fig. 51. C-clamp

2.3. *Powered Tools*

The powered tools should preferably be used after you are conversant with handtools. If your hands are not steady and you have not developed a rough idea of the mechanics of cutting, you are prone to accident. Working with power tools will be a pleasure after you are trained on those and have full knowledge of handling, safety, maintenance etc. The powered tool should always be connected to proper plug and socket. It is to be invariably ensured that the machine body is earthed.

(a) Electric drilling machine: As shown in Fig. 53, this has a switch under the index finger when it is held like a gun. The drill is held in the collet jaw (at the tip of the machine). It is first tightened by hand and then by a key. This is portable as well as can be used on a special stand for accurate and repetitive work.

(b) Electric portable sander: As in Fig. 54, sand paper or emery paper is fixed on the face of the wheel. As the wheel rotates at high speed, it smoothens and polishes flat surface.

(c) Electric blower: The blower shown in Fig 55, blows air at a high speed so as to blow off dust etc. This can also be used in many experiments, where a jet of air with high speed is required.

There are other popular powered tools, e.g. straight grinder, flexible shaft grinder, angle grinder, bench grinder, circular saw, pneumatic drill, abrasive cut-off machine etc These powered tools (particularly grinder and circular saw) run at very high r.p.m. (revolutions per minute) and are not recommended for use by the school students.

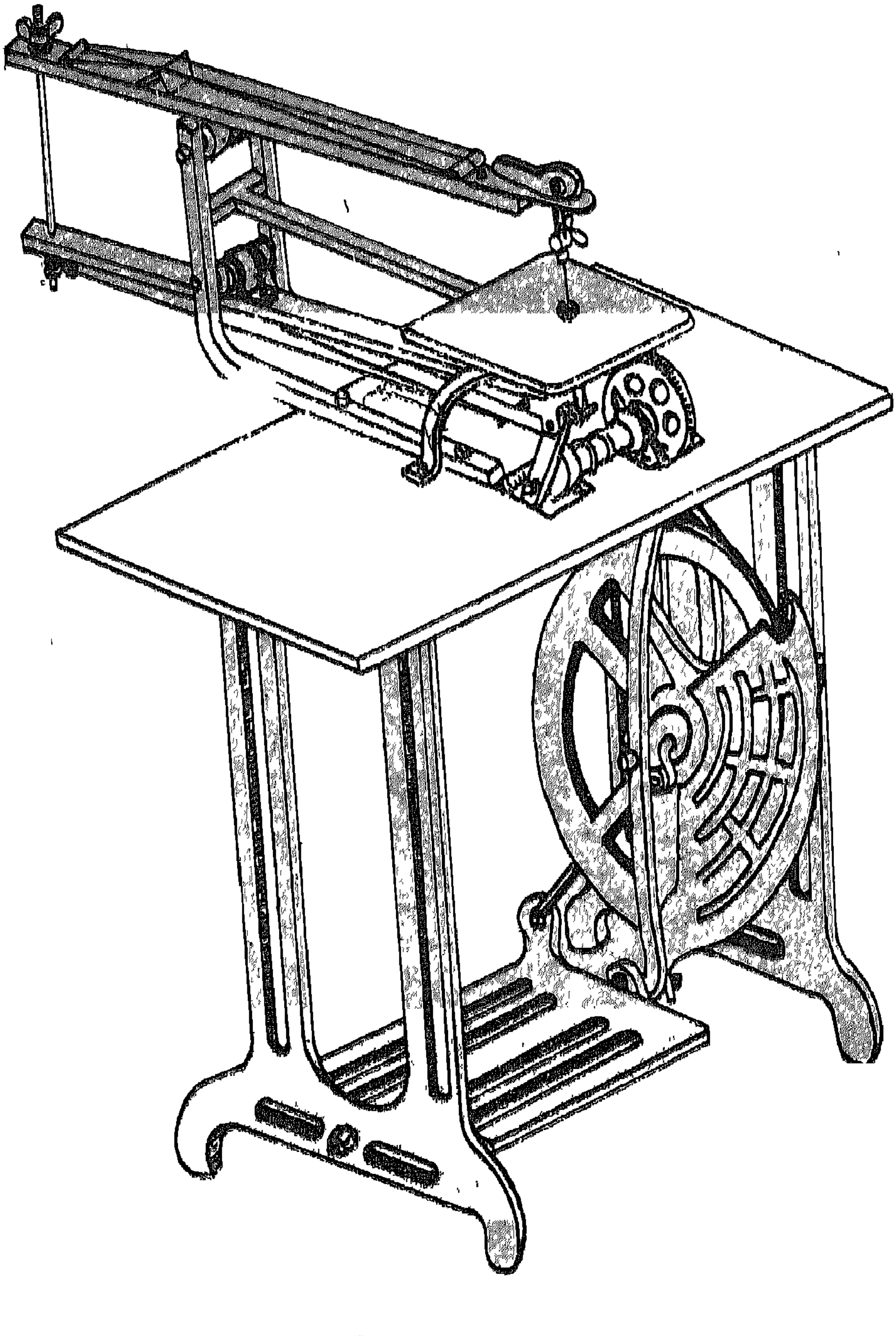


FIG. 52. Fretsaw

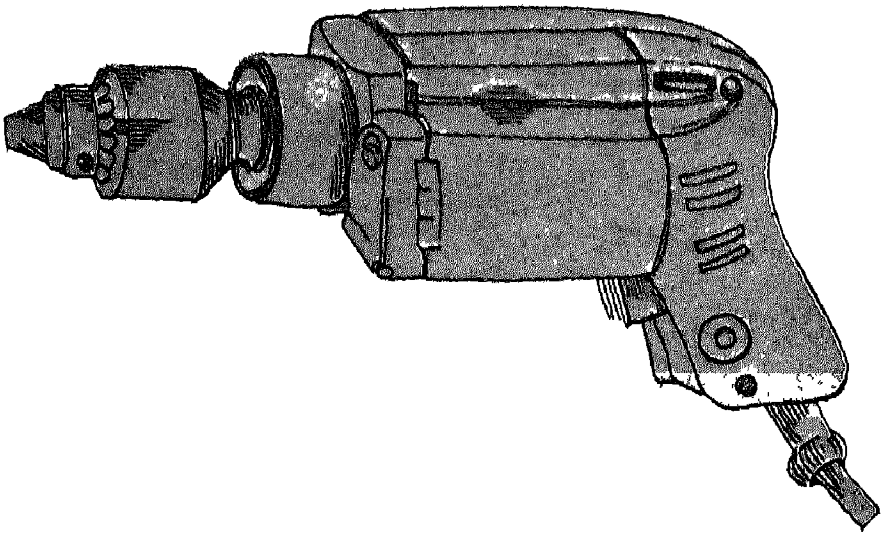


FIG. 53. Electric Drilling Machine

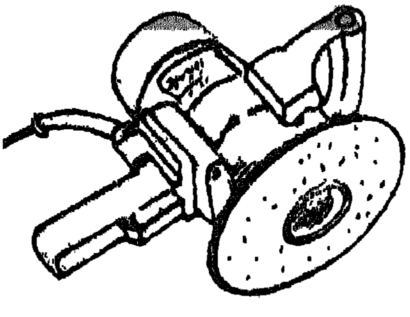


FIG. 54 Electric portable sander

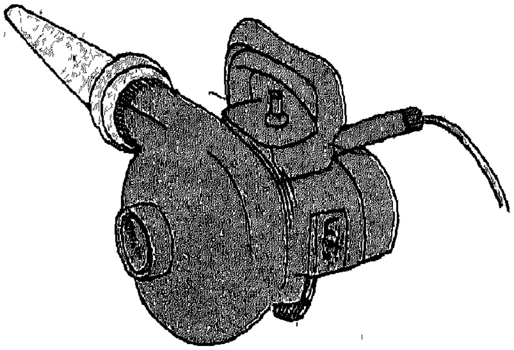


FIG. 55. Electric blower

2 4 *Exercise with hand-tools*

T

Fifteen exercises are given in this section. After doing those on your work table with proper tools, you will gain enough confidence to take up any average fabrication work with common handtools. Additionally you should also fabricate starfinder, hot air balloon, chemical clock, turbidity meter, and make ferro cement products, mud plaster, etc. from the book mentioned at Ref. 12 at the end of the chapter Subsequently you are to take up exercises on measuring tools in Section 2 6 and then on circuits shown in Section 7 of this chapter.

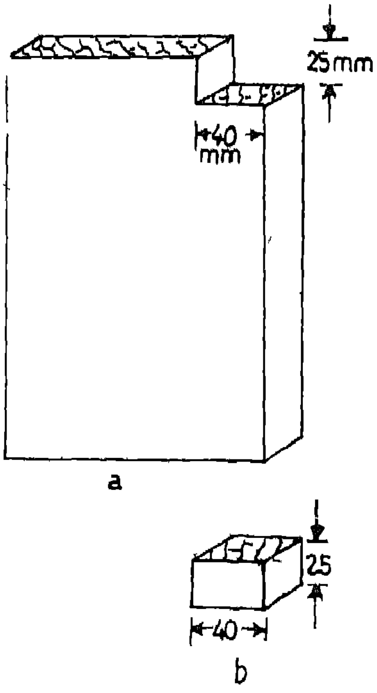


FIG 56 All dimensions are in millimetres.

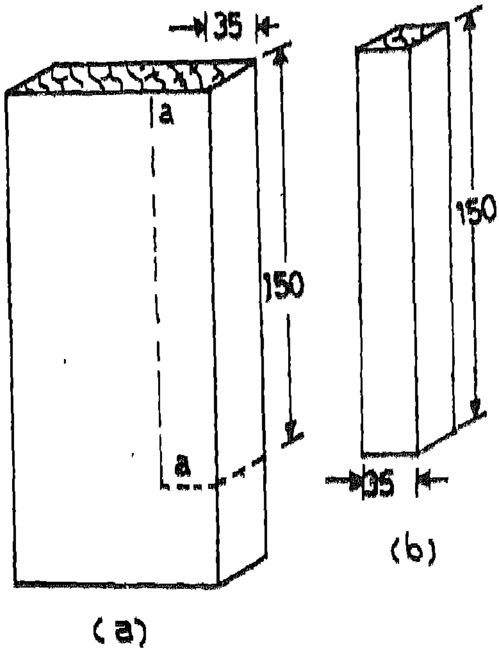
Exercise 1

The top edge of the wooden strip is to be sawn and parted off as shown in Fig. 56.

Tools required: Ruler, vice, junior hacksaw, rasp, marking gauge.

Exercise 2

The wooden strip shown is to be sawn and parted off along the line a-a as shown in Fig 57.



(a)

(b)

FIG. 57

Tools required: Marking gauge, vice, junior hacksaw, carpentry saw, rasp.

Exercise 3

A cylinder is to be shaped as shown out of the parted off strip in exercise 2 (Fig. 58).

a— rough piece.

b— after smoothening all faces, check perpendicularity of faces and mark lines

c— after clamping in the vice cut edges, remove corners to make a cylinder

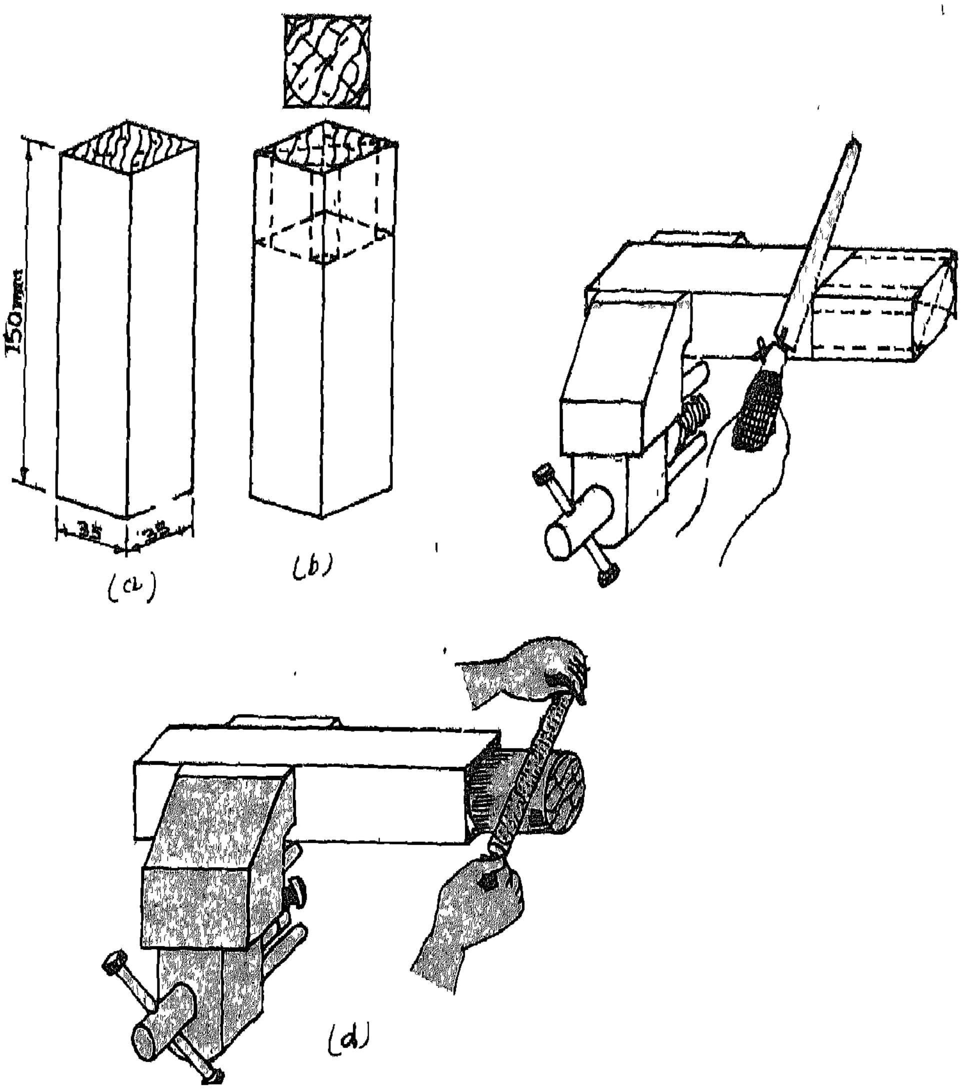


Fig. 58

d— finish the cylinder with the help of the rasp

Tools required Vice, ruler, marking gauge, carpentry saw, junior hacksaw, rasp.

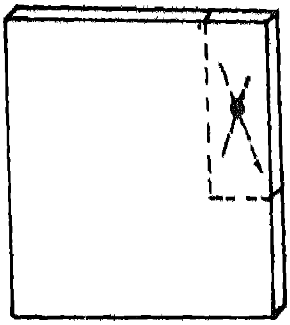


FIG. 59

Exercise 4

A plastic strip is to be cut along the line shown in Fig. 59. The faces of the parted off small strip are to be smoothened and sharp edges are to be removed. A hole is to be drilled at the centre of the small strip. Proportionate dimensions are to be assumed.

Tools required: Vice, file, junior hacksaw, carpentry saw (while sawing apply water on the cut surface by squeezing a wet cloth), drilling machine.

Exercises 5 and 6 (Figs. 60, 61)
Two blocks of wood are to be finished to dimensions of L (Length) and W (width). Exact dimensions may be decided on the basis of available materials. The final shapes of the blocks are shown and the operations are mentioned.

Plan tools and fixing of the job. Mark the finished dimensions with a pencil on the raw materials. Take help of your teacher/guide; follow the steps (a) to (c) to arrive at the shape at (c).

Tools required: Vice, ruler, try square, drilling machine, rasp, chisel, hammer, plane, junior hacksaw, carpentry saw, file, marking gauge

(a) Marking, planing, filing, making perfect rectangle

(b) Drilling, chiselling, filing, finishing slot

(c) Rounding corners, drilling four holes

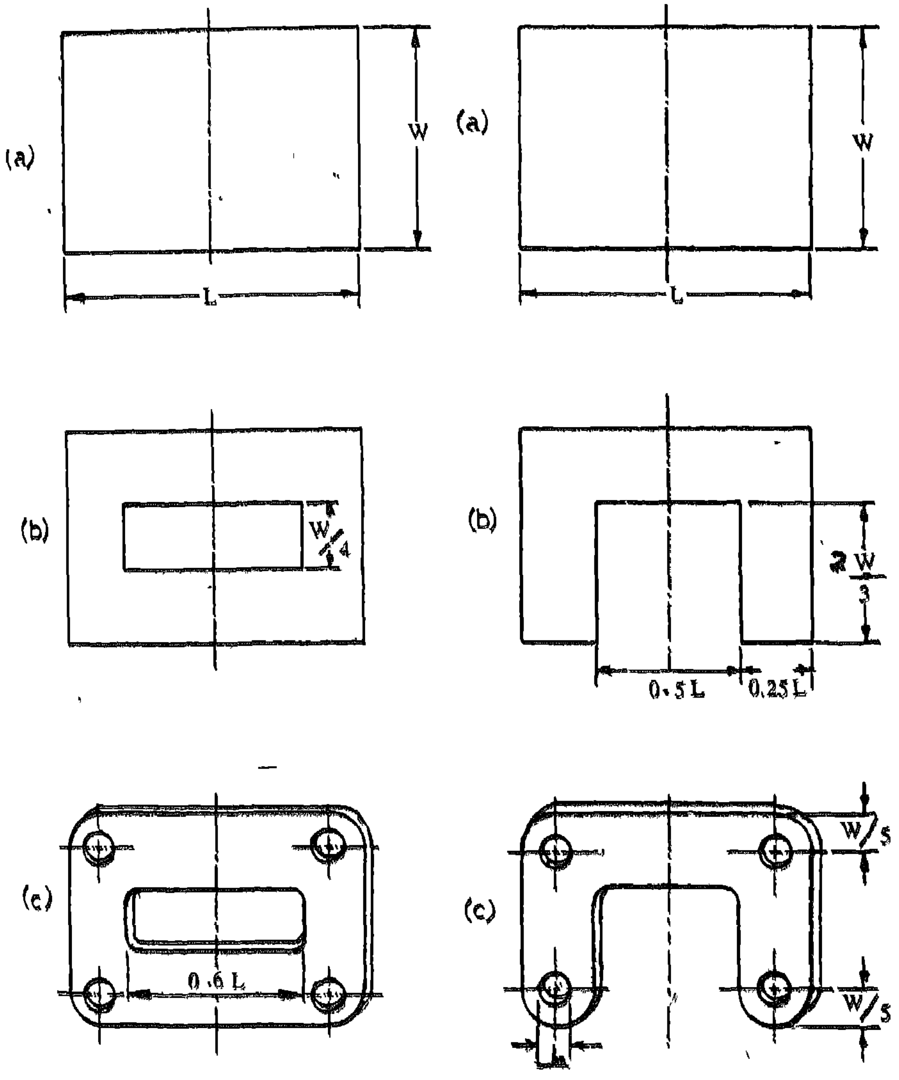


FIG. 60

Exercise 7

Two identical blocks of wood are to be shaped as at (a) and (b) of Fig. 62 and joined as shown at (c). This is a 'half lap' joint. For a perfect joint each part has to be finished accurately. Take help of your teacher/guide for preparing the joint.

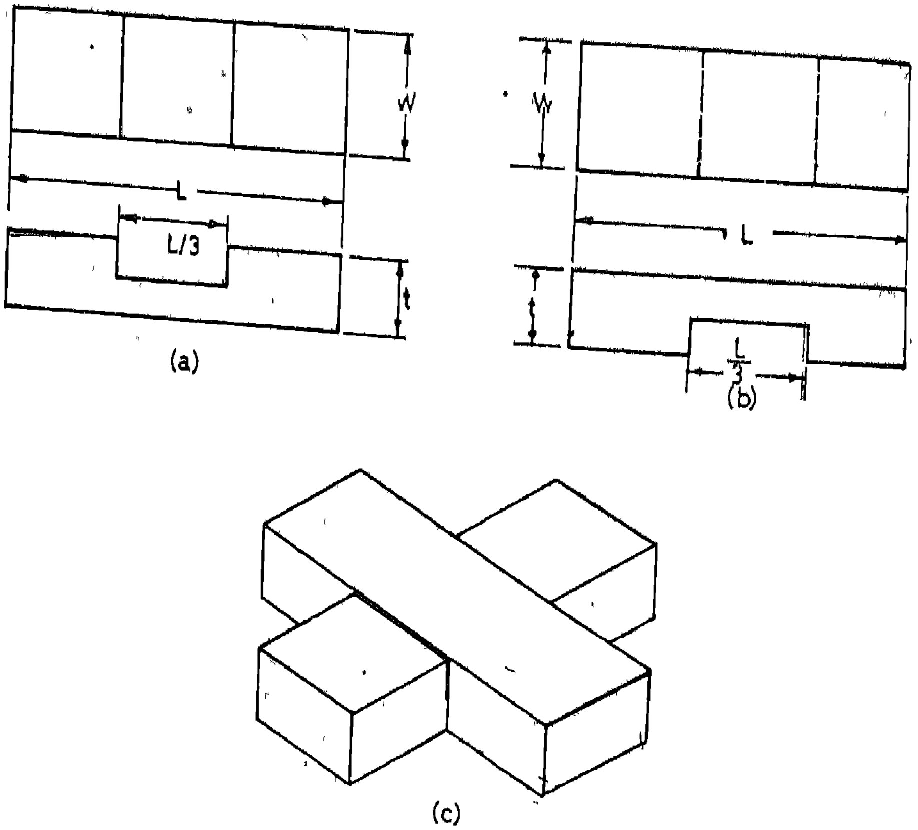


FIG. 62

Tools required: Vice, plane, ruler, try square, marking gauge, junior hacksaw, carpentry saw, chisel, hammer, rasp, file

Exercise 8

This is a sheet metal (aluminium sheet) work (a) Choose a size L × W as available (b) Cut and knock out shaded portions (c) Now bend along the dotted lines to get a box without cover Such boxes are made to house electronic circuits Switch, indicator lamps, incoming and outgoing electrical connections, etc are fitted on one of the vertical surfaces, while heavy parts like transformer etc. are screwed on to the bottom of the box Addition of a detachable top cover (not shown here) completes the box (See Fig 63)

Tools required Shear Snip, vice, ruler, file, drilling machine

Exercise 9

PULLEY

We have seen how a pulley is used in lifting a bucket of water from a well. Using a combination of such pulleys one can lift heavy loads with small effort *How to make* Wooden or plastic reels are thrown away by users after the thread/tape is consumed These reels are of various sizes, one of 37 mm diameter × 35 mm length with, a central hole can be taken Iron wire 3 mm diameter × 150 mm long may be taken and bent in the form of a frame as shown in Fig 64 It is then fitted in the reel so that it can be suspended from a stand or hook for lifting an object

Tools required Ruler, vice, hammer, pliers, saw, file

Exercise 10

TRIPOD STAND

For stability at least three supports are required A container having liquid

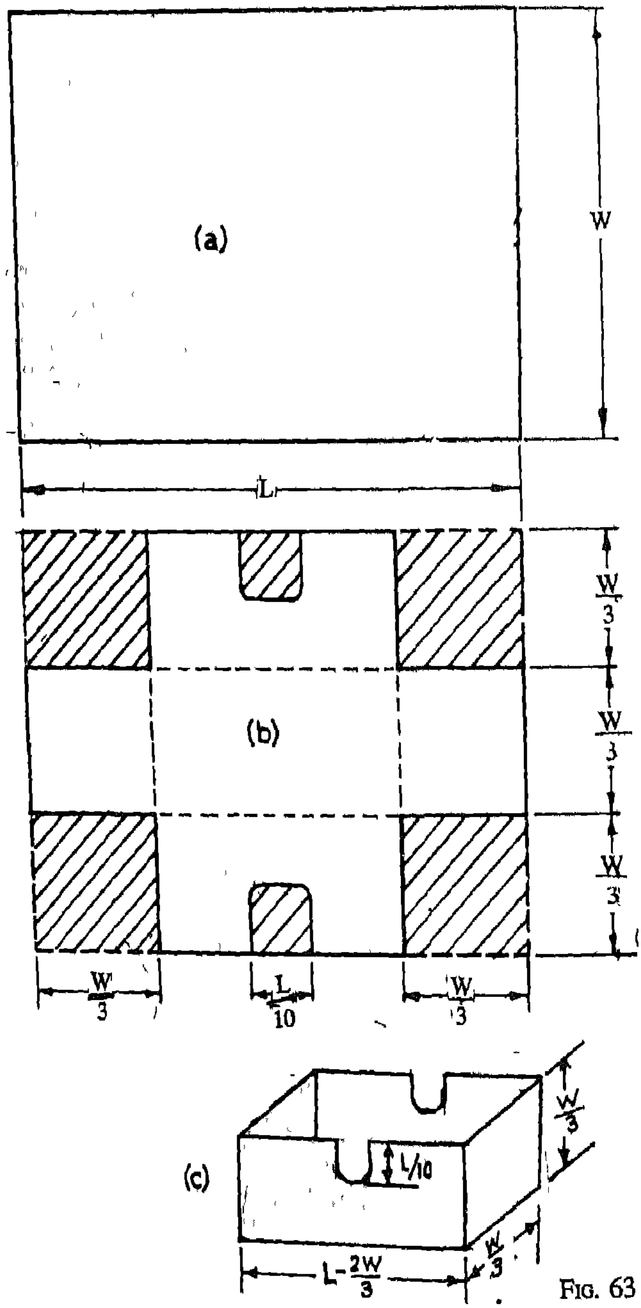


FIG. 63

or any substance to be heated is placed on the tripod stands; the bottom of the container is heated by a burner.

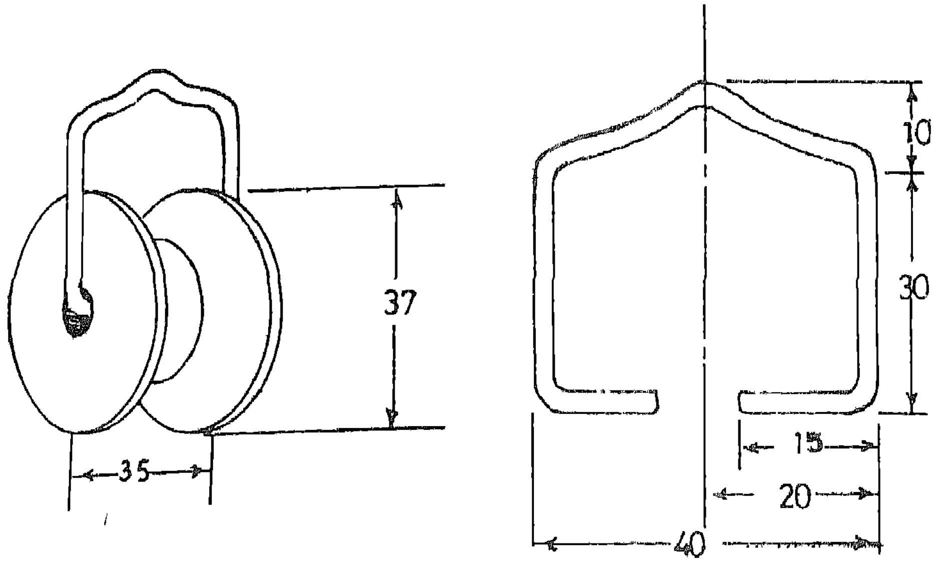


FIG 64

How to make Three pieces of wire each nearly 3 mm diameter × 320 mm long are taken They are bent as shown in Fig 65b and finally twisted with the help of the plier as shown in the Fig 65c The twisted legs are slightly bent outwards at the bottom

Tools required Saw, tin cutter cum pliers, vice, hammer, file, ruler

Exercise 11

SPRING BALANCE

A spring balance is used for weighing A thin steel strip nearly 240 mm long is fixed on one end as shown in Fig 66. If any load is put up on the other end, the strip bends downwards. If the load is removed, the strip comes back to its original position (upto a certain value of the applied load). As one puts more load the strip bends more For example if the strip bends through 20 mm under 100g, it will

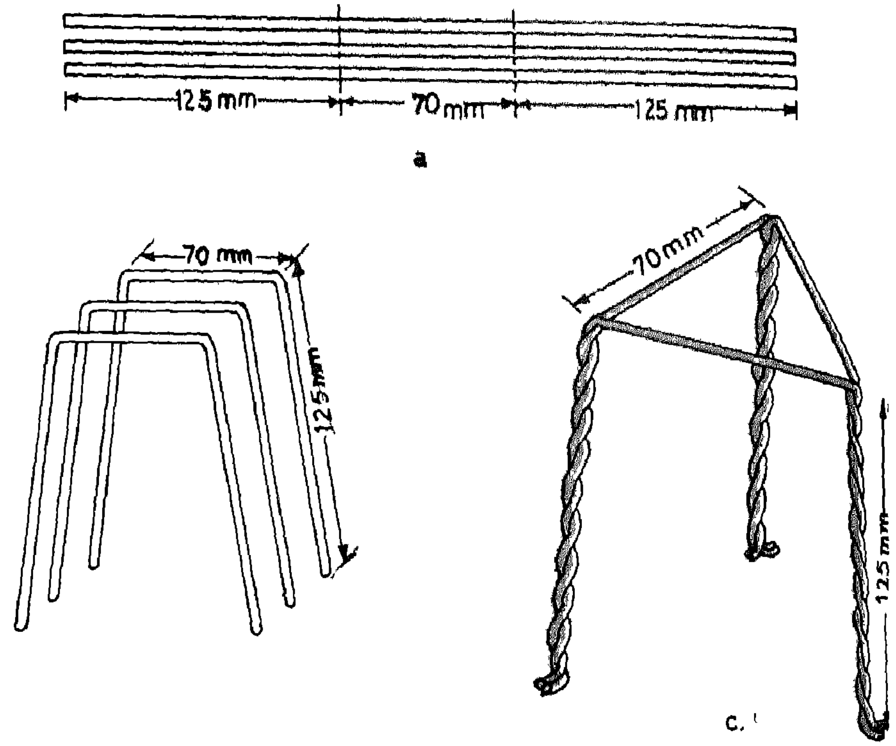


Fig 65

bend 40 mm under 200 g and so on (upto a limit). Spring balances are constructed on this principle.

How to make As shown in Fig 66 the wooden base (part 1) is sized with the help of the vice, saw and half round rasp. Similarly wooden parts 2 and 3 are also sized; part 2 is then joined to part 1 as shown. Similarly part 3 is joined to part 1.

Now cut a fairly straight piece of steel strip from a discarded box strap. One end of the strip is bent so that it can be screwed or nailed to part 2 as shown in Figure On the other end of the strip a metal lid nearly 40 mm diameter is to be fixed by short and thin nails. The pointed end of the nails are to be hammered and made flat.

Mark with a pen or pencil a line on part 3 showing the original position of the strip. Put known weights in steps of 50 or 100g (not beyond 300g) and mark corresponding positions of the steel strip on part 3. Now the balance is ready to read any unknown weight in the range of 0 to 300g.

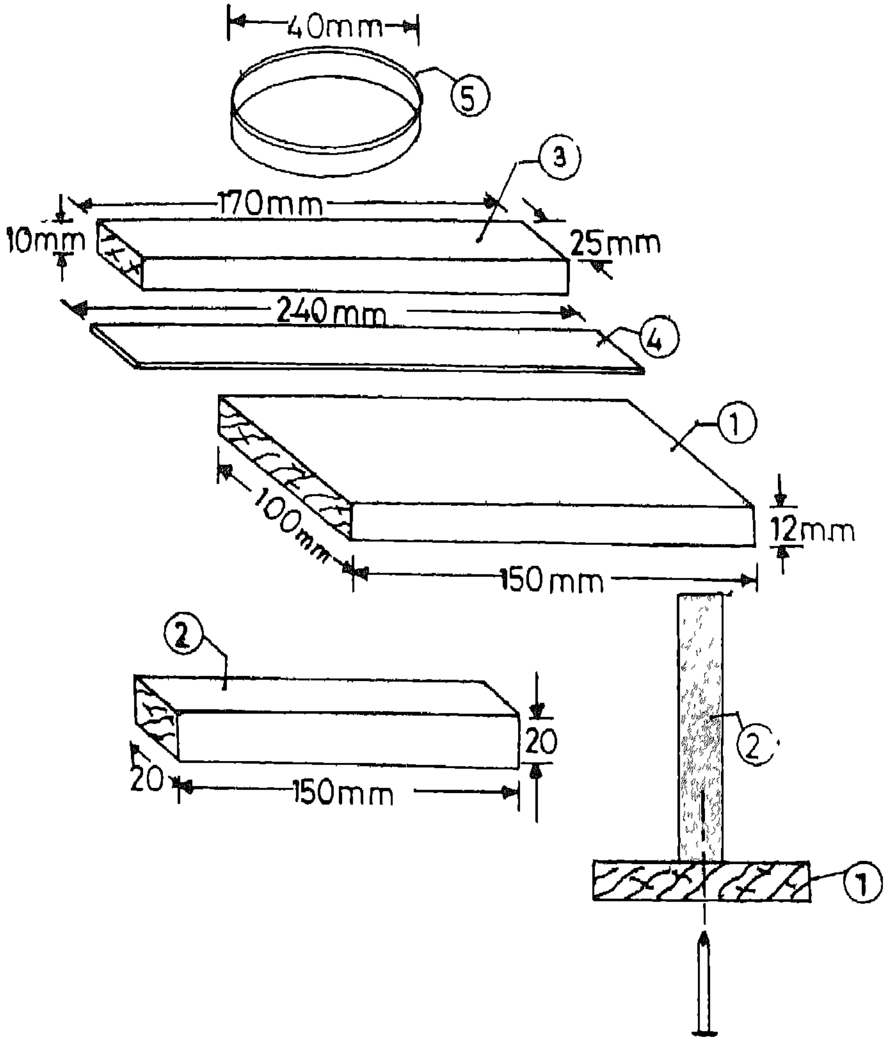


Fig 66

Tool required: Ruler, divider, vice, saw rasp, tin cutter, hammer.

Part No	*Name*	*Material/Nos*	*Remarks*
1	Base, 150 mm × 100 mm × 12 mm	Wood, one	—
2	Support 20 mm × 20 mm × 150mm	Wood, one	—

3	Stand for graduation 25 mm × 10 mm × 170 mm	Wood, one	To be graduated with the help of known weights
4	Steel strap, thin 20 mm × 240 mm × 0 5 mm	Steel (from packing box strap)	To be bent and nailed on part 2
5	Metal lid of a jar 40 mm diam	tin or aluminium	To be fixed with two small nails on part 4
6	Nails	Iron, eight	- -

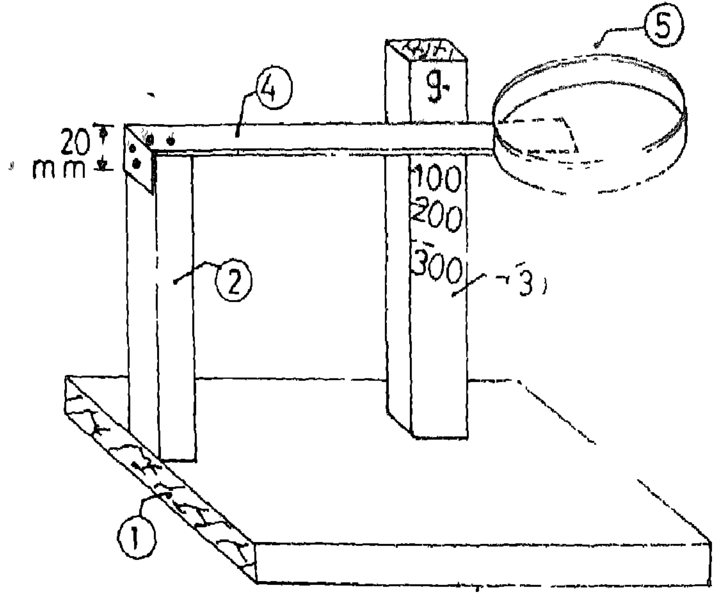


Fig. 66 (contd.)

Exercise 12

Low Cost Stand

Laboratory stand is required to hold different objects at heights suitable for

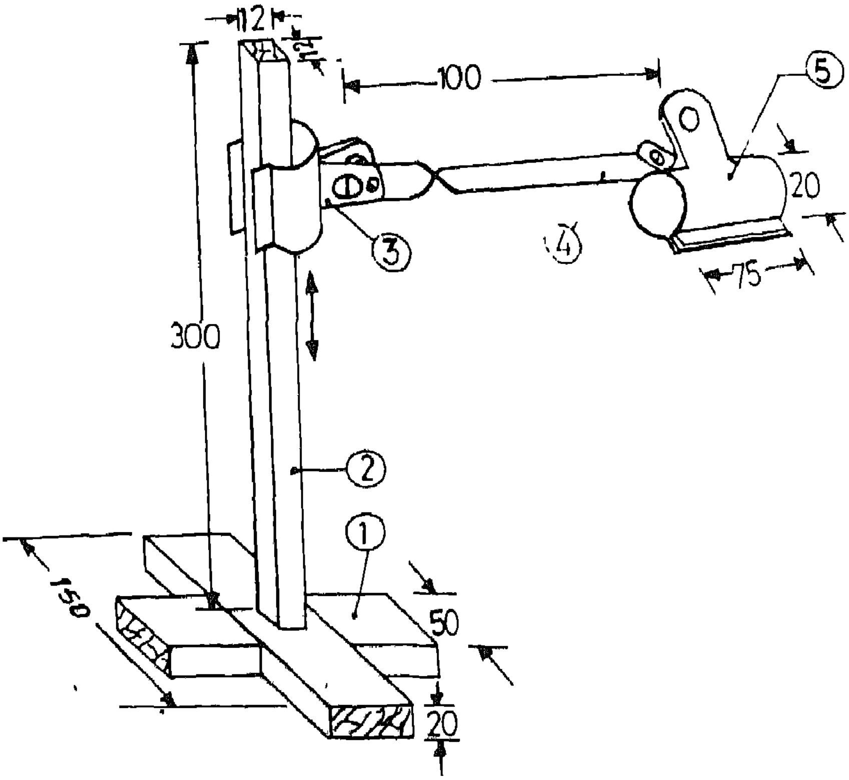


FIG 67

heating, experimentation, demonstration etc So laboratory stand has a stable base, a clamp which can slide vertically and another clamp which can hold objects

*How to make:*Use the base having half lap joint as shown in Fig 67 On this base fix a wooden stand 12 mm × 12 mm x 300 mm. This has to be done by nailing from the bottom side of the base These operations require vice, saw, chisel, ruler, hammer and half round rasp.

Take a steel strip 130 mm × 15 mm × 1 mm thick. Twist the strip with the help of vice and pillers, as shown in Figure. Drill two holes on the sliding clamp end and one hole of the free end of the strip Each of these holes will receive M-3 screw and nut. Now take two pinch clips of nearly 75 mm griping length The strip is now connected with the clips with the help of screws and nuts

Tools required Plane, vice, marking gauge, hand drill, saw, chisel, ruler, screw driver, pliers, mallet.

Materials required:

Part No	*Name*	*Material/Nos.*	*Remarks*
1	Wooden pieces 150mm × 50 mm × 20mm	Soft wood, two	For making half lap joint.
2.	Vertical piece	Soft wood	To be fixed at the centre of the joint
3.	Nails 25 mm	Iron, two	—
4.	Metallic strip 25mm × 5mm × 1mm	Mild steel, 1No.	—
5	Screw M-3 and nut	3 pairs	—
6	Pinch clips, grip-75 mm	Mild steel, two Nos.	—

Exercise 13

CIRCUIT BOARD

This will be your home-made circuit board. This will allow you to try electronic circuits with various components without actually soldering a single joint, you are to insert the two terminals of the component (resistor, capacitor, bulb, motor etc) in appropriate springs; the choice of springs will depend on whether the component is to be connected in series or in parallel Nearly 20 mm of insulation of the connecting wire end is to be removed; the spring is to be pulled with two fingers to make a gap between the spring coils, the connecting wire end is now inserted and the spring is released.

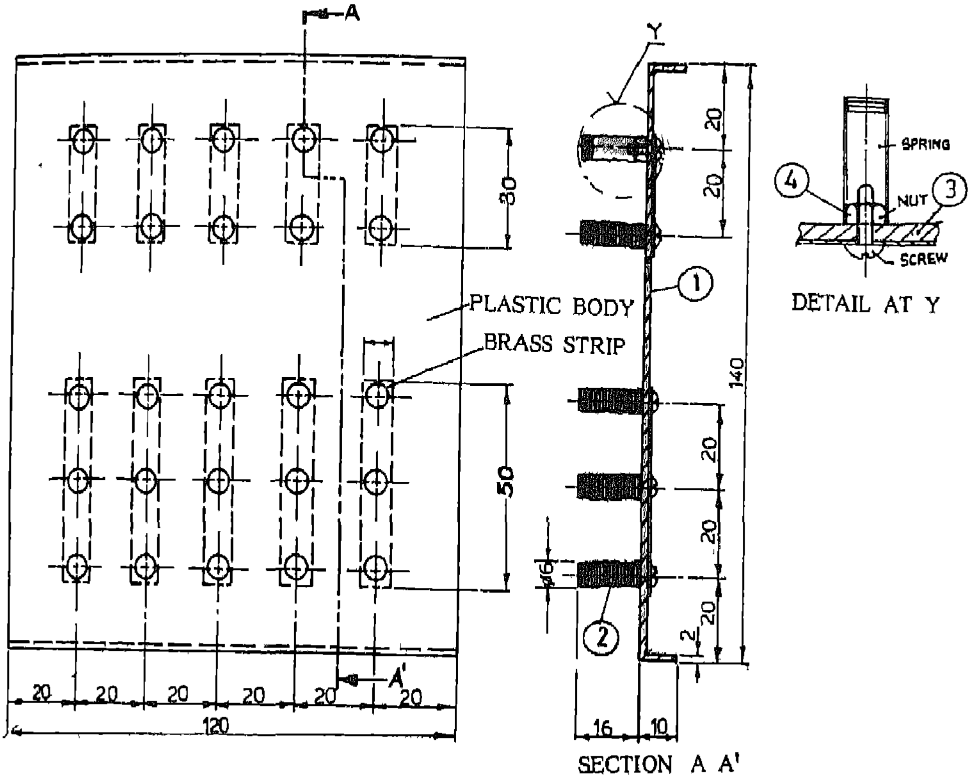


FIG 68

Tools required Nichrome wire cutter (refer to Fig 91) shear snip, vice, ruler, file, pliers

Materials required·

S No.	*Name*	*Materials*	*Remarks*
1.	Base	Wood or Plastic	3 × 5mm beading on the underside (in case of wood)

2	Spring, closed coil, 6mm dia × 20mm long	Steel, 28 SWG plated, 25 Nos.	
3	Metal strip 400mm long × 8mm wide × 1 to 2mm thick	Copper, brass or aluminium 50mm long-5 Nos., 30mm long-5 Nos.,	To be fitted on the underside with screws and nuts.
4.	M-3 screw and nut.	m s.	25 pairs

Exercise 14

Buzzer

As shown in Fig. 69a, when the terminals are connected to a 6 volt battery, the current through the copper winding magnetises the bolt (6) which attracts the flat spring (5). As the flat spring moves down, it loses contact with the screw (10); hence the continuity of circuit is broken and the bolt loses magnetism. Consequently the flat spring moves up and makes contact with the screw again. This cycle of make and break is repeated and the flat spring makes buzzing sound as it keeps on striking the screw end.

You will find application of relays in Fig.108 In relays the contact between the screw end and flat spring is 'on' or 'off' depending on the magnitude of current through the coil. If the current in the coil is high enough to *hold on* the flat spring down on the coil top, another circuit (using the contact between the screw end and flat spring as switch) remains open; it closes when the flat spring is released (due to no or low current in the coil). You should procure a relay from any shop dealing in electrical spares and examine its construction

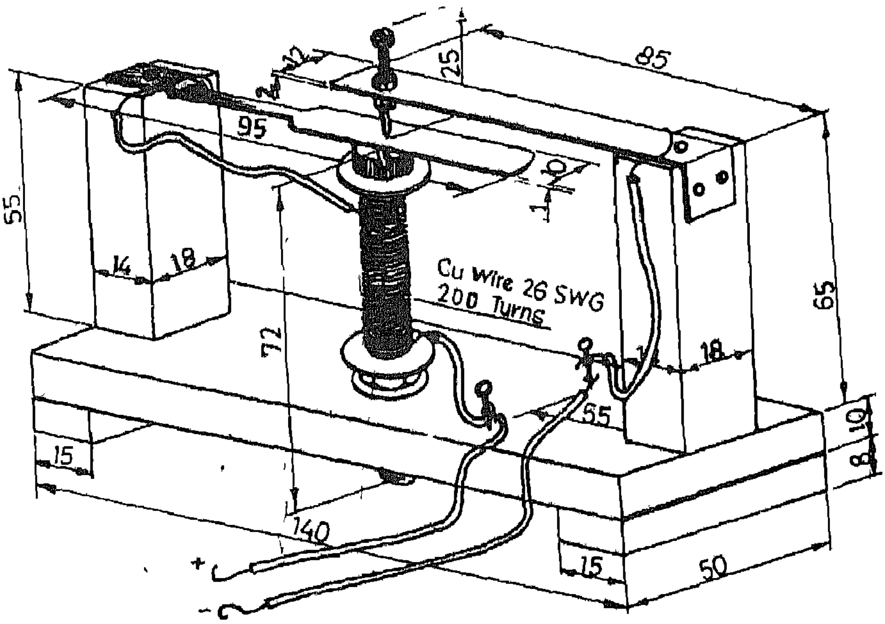
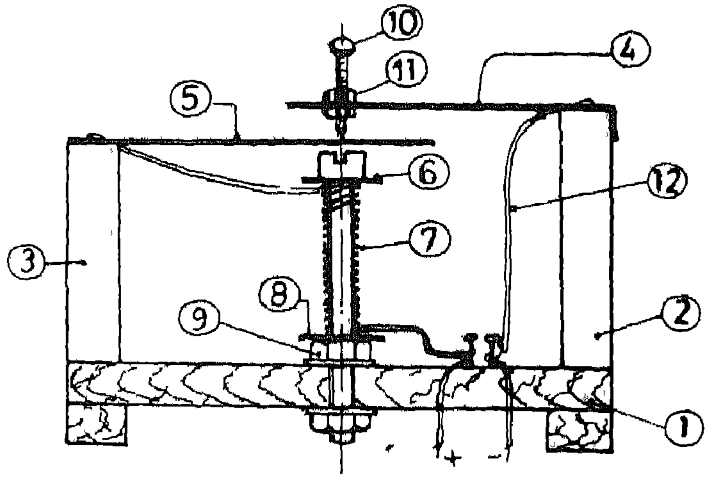


FIG 69 (a)



SECTIONAL VIEW

FIG 69 (b)

Materials required

S.No.	*Name*	*Materials*	*Remarks*
1	Base	wood	to be painted
2	RH Upright	wood	to be painted
3	LH upright	wood	to be painted
4	Metal strip, 10 SWG	mildsteel	to be fixed on the upright by screws.
5	Flat spring	steel	from box strapping, to be fixed on the upright by screws.
6	Bolt (M 6 × 65 long)	mild steel	
7	Winding, 26 SWG, super enamelled copper wire, 200 turns	copper	insulation at the ends to be scraped off.
8.	Washer 20/8 dia	m.s	4 washers are required as shown.
9	Nut M6 hexagonal	m.s.	2 nuts to be tightened on the bolt as shown.
10	Screw M 3 × 25 long	m.s.	the end is to be ground and tapered.
11	Nuts M3, hexagonal	m.s.	2 nuts to be tightened on 10 as shown.
12.	Super enamelled copper wire for electrical connection, 26 SWG, 600 mm long with sleeves	copper	
13.	Nails, 25 long		2 nails to be used to join connecting wires as shown.

Tools required: Vice, plane, file, shear snip, hammer, screw driver, pliers, spanner, hand drilling machine, ruler, scriber, try square.

Exercise 15

Electric Motor And Pump

As shown in Fig 70(a) the pump (3) which is driven by electric motor(1) lifts water from the tank(13). Electric motor is the prime mover in most working models. one chosen here (refer to table) is of specifications. 1/15 HP, 1275 RPM, 230V. The motor and pump assembly is shown in Fig 70(b). As the shaft (2) rotates, impeller of the pump rotates in the pump housing When there is enough water in the tank so that the impeller in the pump housing is totally submerged, the rotating vanes of the impeller push water through the delivery nozzle with some pressure. This

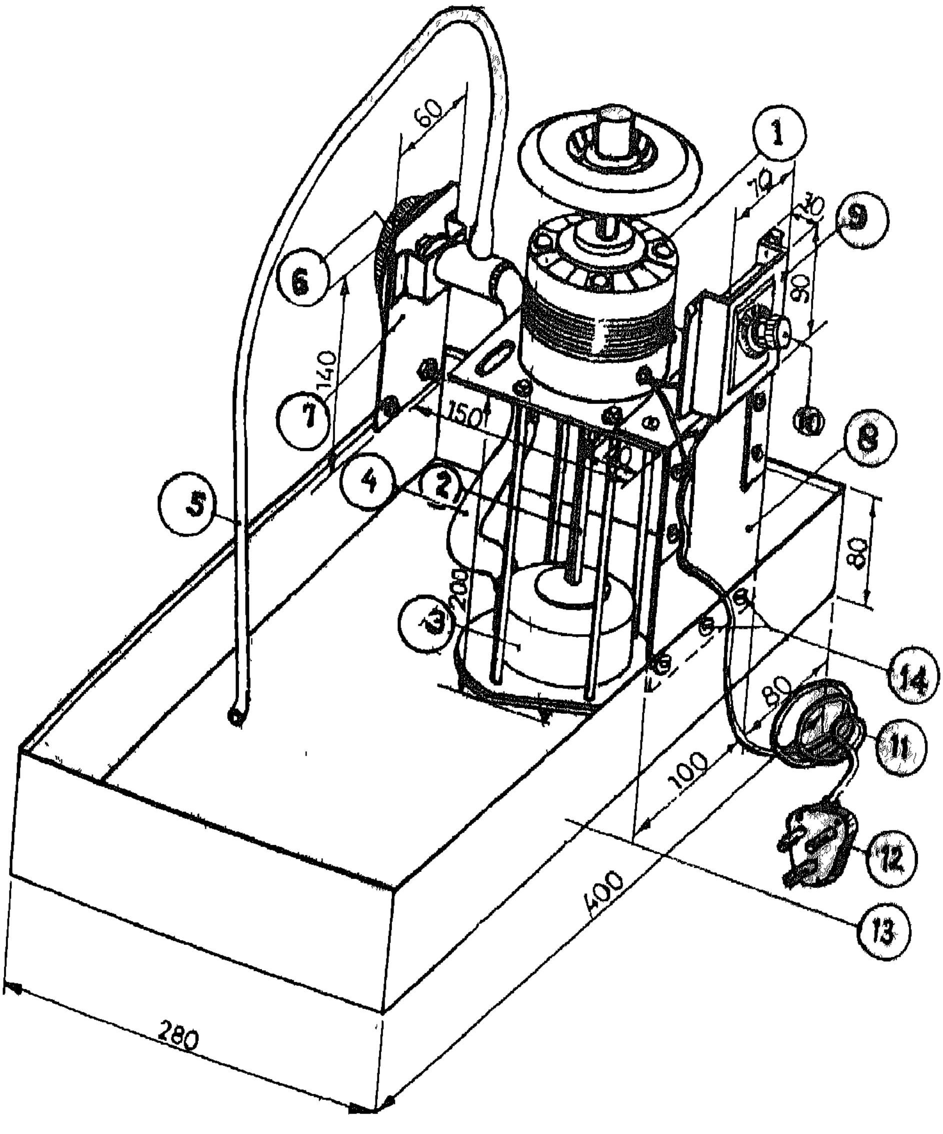


Fig. 70(a) A.C motor and pump to lift water particular pump does not suck water, it delivers water from one level to another. There is a valve (6) for flow adjustment on the delivery side. It can be adjusted to any rate of flow within the range of zero to full pipe A solid state regulator (10) have also been fitted. This regulator controls the speed of the motor. You can get six different speeds within the range 0 to 1275 revolution per minute(RPM).

This set up is easy to fabricate and is useful for any water cooling arrangement in experiments/models. This can also be used for demonstration of *velocity head*, *pressure head* etc during flow of liquid. Further you can use the rotation of the motor (in the same position) for various exhibits and displays. This arrangement is the answer to the problem given on page (moving display).

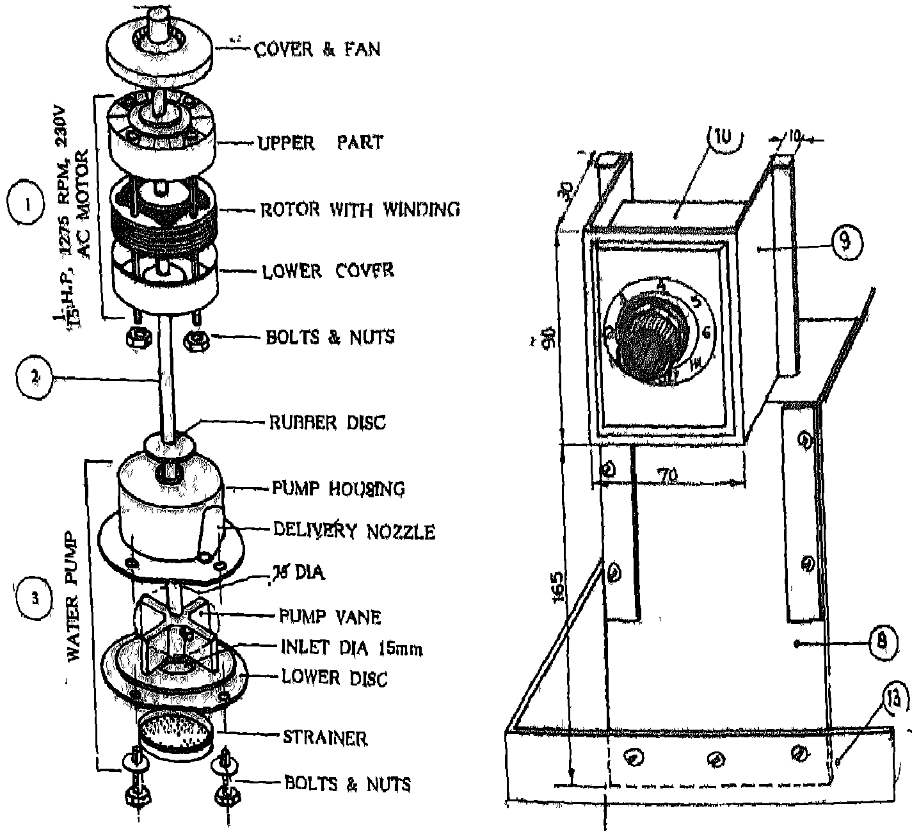


Fig. 70 (b) Exploded view of motor pump
(c) Fitting of regulator frame,(9) in guides of (8)

Materials required

S.No	Parts	Material	No	Remarks
1.	AC motor, HP-1/15, RPM-1275, 230v		1	
2.	Shaft 8mm dia	m s.	1	integral with 1 and 3
3	Pump with Vane 75mm dia	plastics	1	intergral with 1 and 2 (available in shops dealing in cooler parts)
4.	Delivery pipe 12mm/18mm dia × 200mm long	plastics (transparent)	1	
5.	Delivery pipe 8mm/14mm dia, 600 mm long	plastics (transparent)	1	
6	Valve flow adjustment	plastics	1	
7.	Supporting plate	m.s	1	to be screwed to the tank wall, painted.
8	Supporting plate	m.s.	1	-do-
9.	Frame for holding regulator	m.s.	1	to be painted
10.	Regulator, solid state 100 watt, 230v		1	
11.	Wire PVC-3-core copper wire 23/76, length 2,5 mts		1	
12.	Three pin plug 5 amp, standard.		1	—
13.	Water tank 400mm × 280mm × 80mm, 24 swg.	m.s	1	painted all over, inside to be specially painted with tar
14.	Screw and nuts M-3	m s.	13 pairs.	

Tools required · Shear snip, vice, file, hand drill, drill bit, screw driver, spanner, electrician's pliers, line tester

Caution · Do not switch on the motor if earth wire is absent or not properly connected.

2 5 *General measuring and marking tools for mainly fitting, sheet metal, carpentry and machine shop practice.*

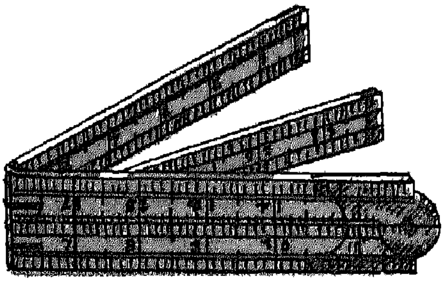


FIG. 71

(a) Ruler and tapes.Rulers are generally made of wood or metal and graduated in millimetres as well as in inches Types are: bench ruler, folding ruler, steel ruler, push pull steel tape, wind up tape, etc Commonly used steel ruler is 15 cm (6 inches) or 30 cm (12 inches) long, having both millimetre and inch graduations and the least counts are 0 05 mm and 1/64 inch respectively Wooden folding ruler is very convenient for storage and is generally used by carpenters. *Push-pull* steel tape is generally 1 to 3 metres long and has a plastic or fireglass case. *Wind up* tape may be of steel or rubberised/synthetic material which is used to measures longer distance of 10 to 30 metres

(b) *Vernier Caliper* It has unique advantage of being used as an outside, inside and depth gauge An ordinary vernier caliper for average measurement has graduations up to 125 mm on the lower side and 5 inches on the upper side of its body A vernier constant of 0 1 mm is common on ordinary calipers

Insert the object to be measured between the jaws Read the main scale mark which has just been crossed by 'O' mark on the vernier The measurement of the object will be;

Main scale reading + Vernier scale Reading x V C

('Vernier Scale reading' means the particular mark on the vernier which exactly coincides with any main scale mark).

In Fig 72 (b) 9 divisions of main scale coincide with 10 divisions of vernier scale. Value of one small division on vernier scale is $\frac{1 \times 9\text{mm}}{10} = 0.9\text{mm}$

Vernier constant (V C)= 1 mm–0.9 mm = 0 1 mm

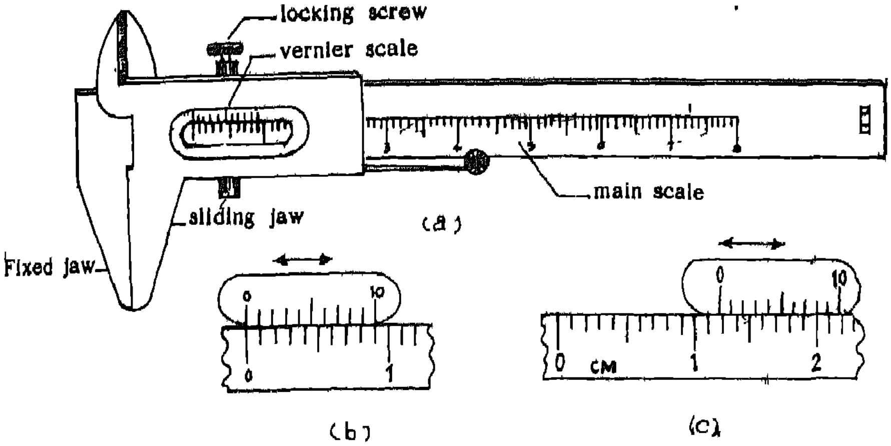


FIG. 72 Vernier Caliper

A vernier caliper with a vernier constant of 0.02 mm is used in precision measurement. In another design a dial which is fitted on the movable jaw gives the measurement. Vernier height gauge works on the same principle and measures vertical distances It has a heavy base, a vertical scale and a sliding vernier scale with scriber

(c) Micrometer It is used in precision measurements Three different types are generally used i.e. outside, inside and depth micrometer. The first type is most commonly used; sizes are from 0 to 25mm (0-1 inch), 25mm to 50 mm (1 inch to 2 inches) and so on. It is made of special steel.

When rotated, the thimble advances on the stationery main scale through a nut and screw mechanism. The movable rod also advances along with the thimble.

An inch micrometer has a minimum division of 0.025 "(pitch of screw is 1)" on the main scale The thimble scale has 25 divisions so as to facilitate measurement upto 0.001 inch. The main scale of a metric micrometer has a minimum division of 0.5mm (which is the pitch of the screw) and the thimble is divided into 50 parts so as to offer a least count 0.01mm; in a *vernier micrometer* a vernier scale is attached to the circular scale, this gives more precise readings. In the new generation it is fitted with a digital display which directly tells the measurement. Measurement in mm = Main scale reading in mm + circular scale reading × 0.01mm.

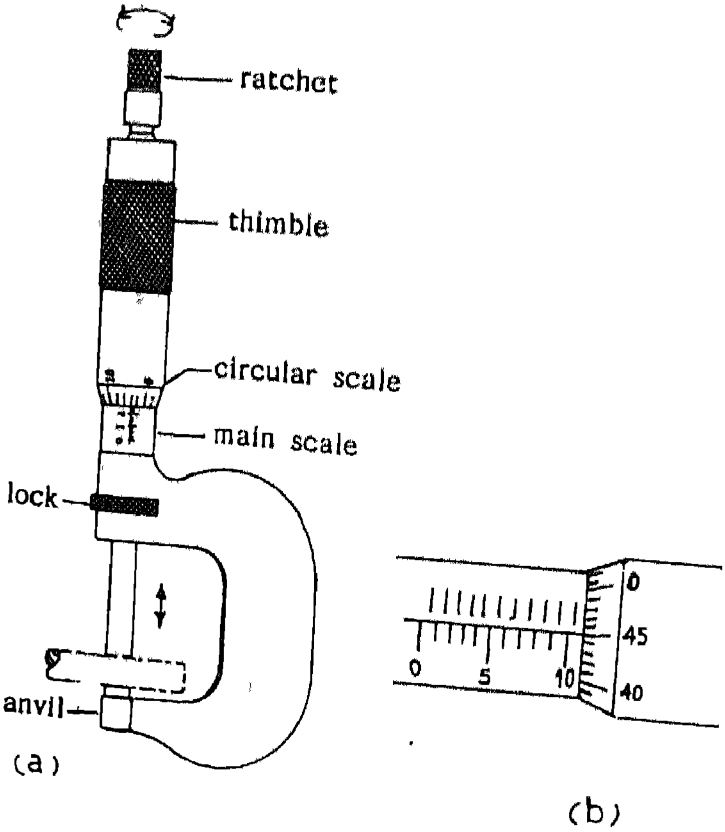


Fig. 73 Micrometer

Take help of your teacher for knowing the correct handling, correct measurement, zero error etc.

Read the vernier caliper as shown in Fig. 72 (c)

What is the diameter of the rod as measured on the micrometer in the configuration in Fig. 73(b).

(d) *Combination Set*: This consists of a square head, a bevel protractor, a centre head and a steel ruler It works as a try-square, square, protractor, centre square, level and ruler.

(e) *Wire Gauge*. It is used to measure the gauge or thickness of metallic sheet or wire. The slots at the periphery are numbered; these are the gauge numbers

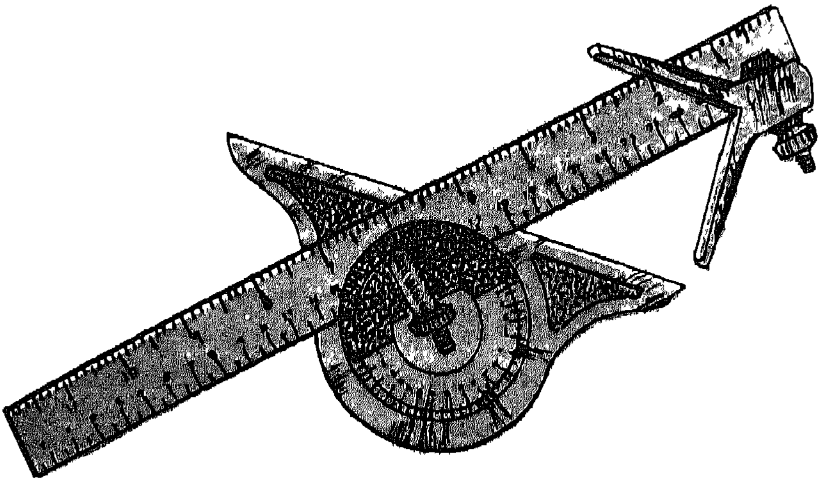


FIG 74 Combination Set

Thickness of any sheet or diameter of any wire is tried in various slots till the correct one is arrived at. Conversion of standard wire gauge (SWG) to inch/mm is printed on the body of the gauge

Remember. 4 gauge = 1/4"

A popular mnemonic is:

if you add 6 to a gauge number, the corresponding inch size is halved So

10 gauge = 1/8"
16 gauge = 1/16"
22 gauge = 1/32"
28 gauge = 1/64" etc

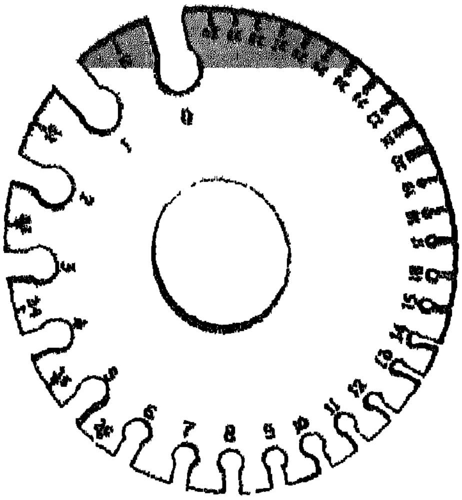


FIG. 75 Wire gauge

(f) *Dial Indicator:* It is used for checking uniformity of dimensions of a contour, the variation of which is indicated on a graduated dial. The object under inspection is to be set properly on a surface plate or the work table of any machine tool. The dial indicator is secured on a stand having a stable magnetic base, vertical rod and clamp. Least count of the dial graduation of an average dial indicator in 0.01 mm.

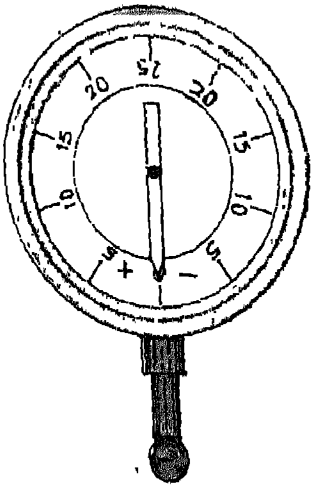


FIG. 76 Dial indicator

(g) *Surface plate:* It is used when lay out work demands accuracy It is made of good grade cast iron, granite or ceramic material. The surface of the plate is lapped to a high degree of accuracy so that it can be used as a reference surface for very accurate marking, measurement, inspection etc

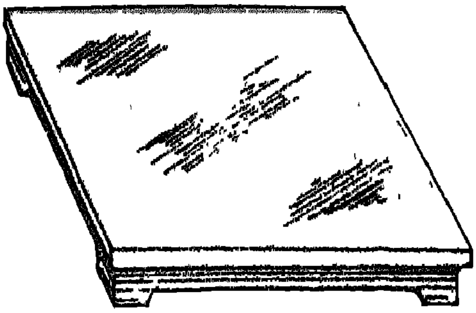


Fig. 77 Surface plate

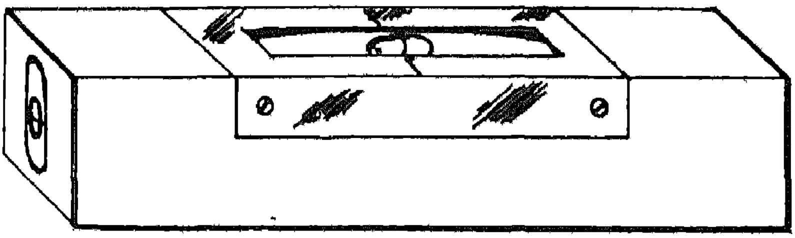


Fig 78 Spirit level

(h) *Spirit level* Its body is made of aluminium/wood/plastics and its minimum size is 75mm. It is used to check whether a surface is perfectly horizontal or not; it is also used in levelling a heavy object so that its horizontal top or bed remains perfectly horizontal during and after installation e.g. surface plate, refrigerator, machine etc.

The curved or straight vial is made of glass or transparent plastic containing clear liquid which may be oil or alcohol. When it is placed on a perfectly horizontal surface, the bubble of air entrapped in the liquid is at the centre.

(i) *Ordinary calipers:* Types are; inside, outside, odd leg, transfer calipers. Measurement of diameter of a shaft by an outside caliper or measurement of the diameter of a hole by an inside caliper can be transferred to a ruler, vernier or micrometer and then the size is read off accurately.

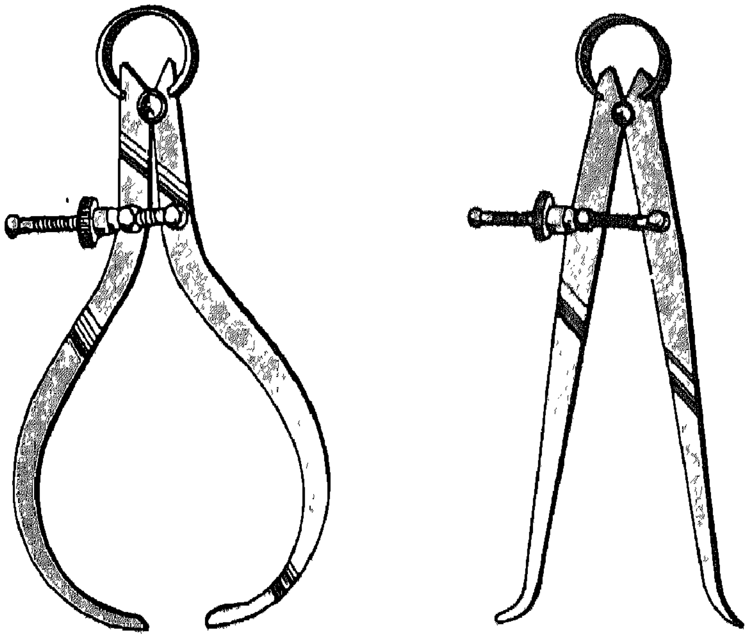


FIG 79 Ordinary calipers

(j) *Try-square:* It has a steel blade, 150 mm to 300 mm long and a cast iron or plastic stock. The blade is fitted in the stock perfectly at right angle. The stock is matched along the reference surface and a line along the blade is drawn on the surface with the help of scriber.

(k) *Scriber:* It is made of tool steel and is generally 4-5 mm diameter. Lines are drawn on job surface with the point.

(l) *Surface Gauge:* It is also called marking block or scribing block. It may be of pillar type or universal type. It has four parts e.g. a stable base, rod, scriber and clamps. It is used on surface plate or machine tool table for marking surfaces accurately.

(m) *Divider:* It is used for measuring distances between points. The distance is transferred to a ruler. It can also describe circles and arcs on metallic or wooden surface. It consists of a pair of a steel legs adjusted by a screw and nut and held together by a circular spring at the top in which is inserted a short handle. It is available in sizes from 50 to 200 mm.

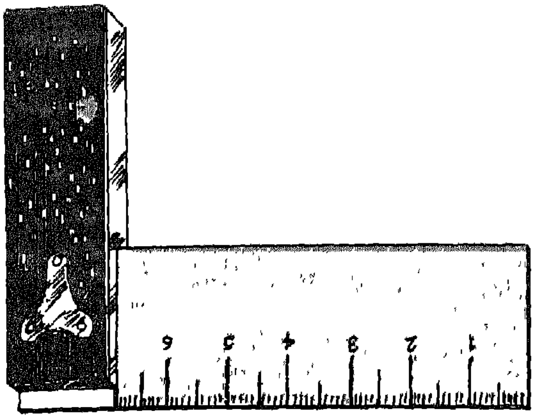


FIG. 80 Try-square

(n) *Trammel* It is a type of divider that is preferred for describing large circles. It consists of a steel bar and two pointed steel legs which are tightened and controlled by screws

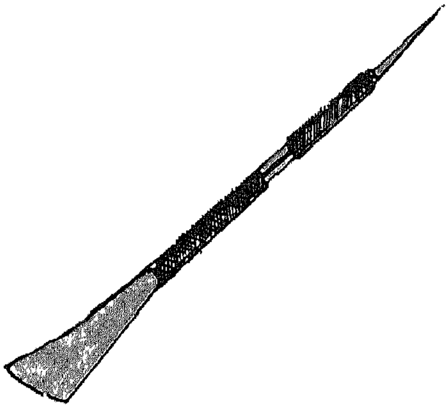


FIG. 81 Scriber

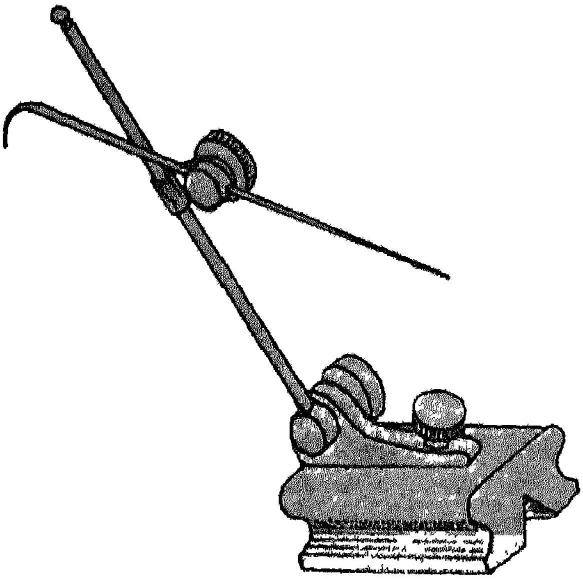


FIG. 82 Surface gauge

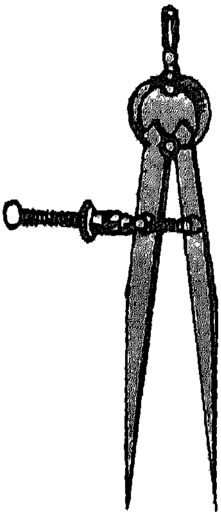


FIG. 83. Divider

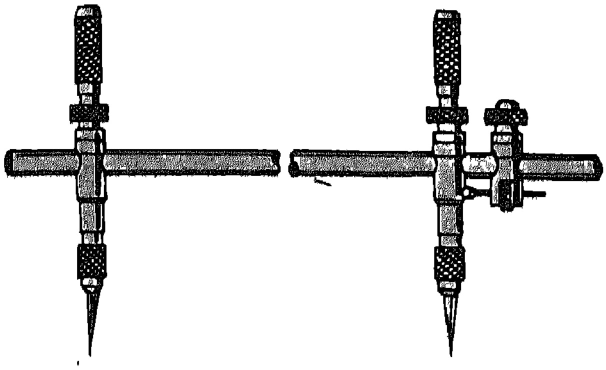


Fig. 84. Trammel

(o) *Marking Gauge:* It is made of hard wood or steel and is available in various sizes from 162 mm to 237 mm. It is used to mark a straight line (on the surface

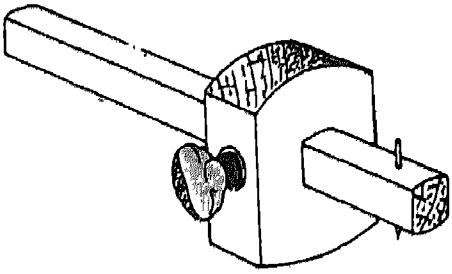


Fig. 85. Marking Gauge

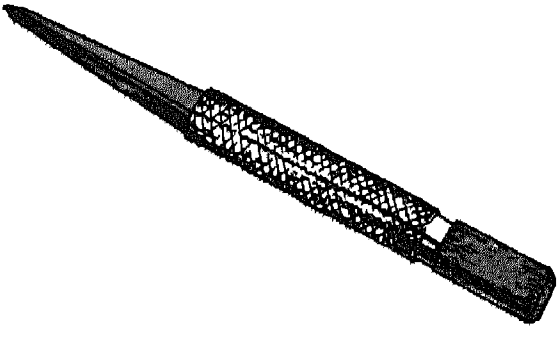


Fig. 86. Punch

of a wood) parallel to its edge. The beam slide in the stock and can be adjusted to required length.

(p) *Punch*. Types are: centre punch, letter punch and number punch. Centre punch is made of steel; one end has a sharp point to indent dots on a surface Letter and number punches are used to punch numbers or letters on a surface

2.6 *Exercises with marking and measuring tools*

(Exercise 16

See Figs. 87 (a) and (b).

Can you

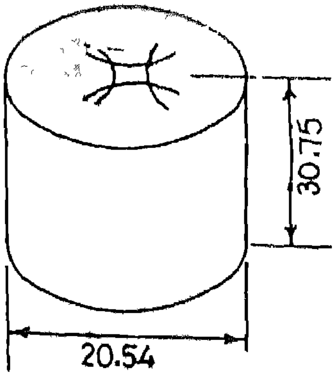


FIG. 87(a)

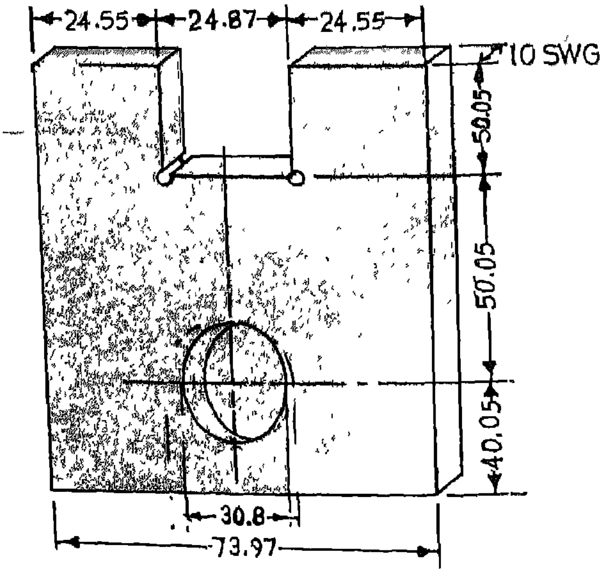


FIG. 87(b)

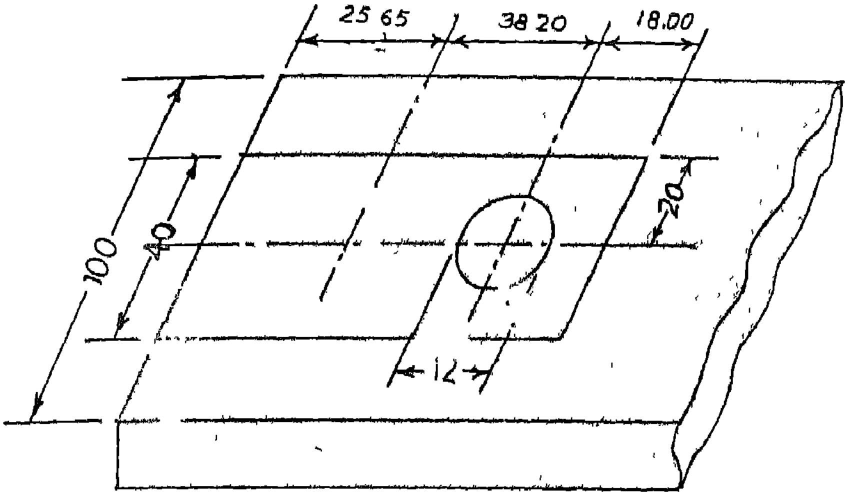


FIG. 88

- name the measuring tool for measuring each dimension in Figs 87(a) and (b)
- Set up the dimension on the tool in each case.

Exercise 17

Take a flat thick metal sheet as shown in Fig. 88. Rub chalk on its face first and then draw fine lines with a pointed steel scriber as per dimensions given in Fig. 88.

2.7 *Working with plastics*

(a) Plastics: General

The group of substances with very large molecules to which plastics belong are called polymers. Plastics are of two types. Thermo-plastics and thermosetting plastics Thermo-plastics can be processed or recycled more than once where as thermosetting plastics become hard after first thermal processing and cannot be recycled Examples of these two types are given below;

Thermoplastics

Material	*Use*	*Salient properties*
Low density polyethylene (LDPE)	Squeeze Bottles, Insulation of coaxial cabls, TV serial leads, toys, etc	Transparent as thin films, waxy feel, floats

High Density polyethylene (HDPE)	Bottle crates, basket, containers, toys, etc.	Transparent as thin film, fairly stuff and hard, floats.
Polypropylene (PP)	utensils, boxes, dashboard, mudguard, cooling fan, meter housing, luggage etc.	Transparent as thin film stiff, hard, floats.
Polyvinyl chloride (PVC) rigid or unplasticised	Soft drink bottles, tubes, shampoo bottles, modern gramophone records, pipes, pipe fittings, chocolate box etc.	Stiff, hard, sinks
Polyvinyl choride (PVC) plasticised	Wire and cable insulation, upholstery, garden hosepipes	Transparent, flexible, soft, sinks
Polystyrene (PS)	Food container, disposable cups	Transparent, stuff, hard, sinks
Expanded polystyrene (EPS)	Ceiling tiles, packing for delicate articles (e.g. camera, scientific instruments etc.)	Opaque, white, usually can be crumbled in the hand, very buoyant in water.
Acrylonitrile/butadience/styrene(ABS)	Casing of food mixers & other electrical appliances, radio knobs	opaque, stuff, hard sinks.
Cellulose acetate (CA) including di-acetate and cellulose acetate-butyrate (CAB)	Photographic films, workshop tool handle, (tough and transparent) transparent/flexible box, lids, sunglass, pen, keytops	Transparent, may be flexible, fairly hard, sinks.
Cellulose nitrate (CN)	Table tennis ball	Transparent, may be flexible, very hard, sinks.
Polyester film	Recording tape	Transparent, strong, hard, sinks
Polymethyl methacrylate (PMMA) acrylic	Panel, windows in aircraft, windshield, contact lens, bathroom fittings, false teeth, brush, imitation jewellery	Crystal clear, glossy surface, stiff, hard, sinks

Polyurethene foam (PU)	Upholstery and cushion filling, sold as blocks or slabs	Opaque, soft and flexible, floats.
Nylon (polyamide)	Casing for power tools, gear, cam, roller, fastner, nuts and bolts etc.	Opaque, stiff, hard, sinks.
Teflon	Gasket, sauce pan, frying pan, bearing, packing etc.	opaque, very stiff, hard, sinks.
Thermosetting plastics		
Area formaldehyde (UF)	Domestic electric fittings (plug top, adopters, switch covers)	Light coloured opaque, stiff, hard, 'solid' feel, flakes on cutting, sinks.
Melamine formaldehyde (MF)	Tableware such as 'melaware'	Opaque, stiff, hard, 'solid' feel, flakes on cutting, sinks.
Phenol formaldehyde (PF)	Dark coloured domestic electric fittings (plug top, adopters, switch covers)	Opaque, stiff, hard 'solid' feel, sinks
	Cast phenolics look like gems, used in watch case, handle, buttons, ornament case etc.	
Polyester resin	Used with glass fibre reinforcement to make boats and car bodies, translucent roofing and door panels.	Stiff, hard, 'solid feel', brittle, sinks.

Manufacturing processes to make various forms of plastics are Calendering (for making films or sheet), Extrusions (rod, tube etc.), Injection Moulding (any desired shape), Blow Moulding (bottles etc), Compression Moulding (plug tops etc. from thermosetting plastics), Transfer Moulding (combination of Compression and Injection Moulding), Casting (mounting biological specimen etc), Plastics Coating and Lamination (coating of wire mesh, basket etc).

(b) *Special Tools for working with plastics*

T Marking, measuring and cutting hand tools which work on wood or metal will generally work on plastics also with the exception that heat due to friction at the tool point might soften the job and spoil the finish; this situation may be avoided by slowing down the cutting or filing operation and using water as coolant. Some of simple techniques for shaping plastic with the help of machines and tools are given below:

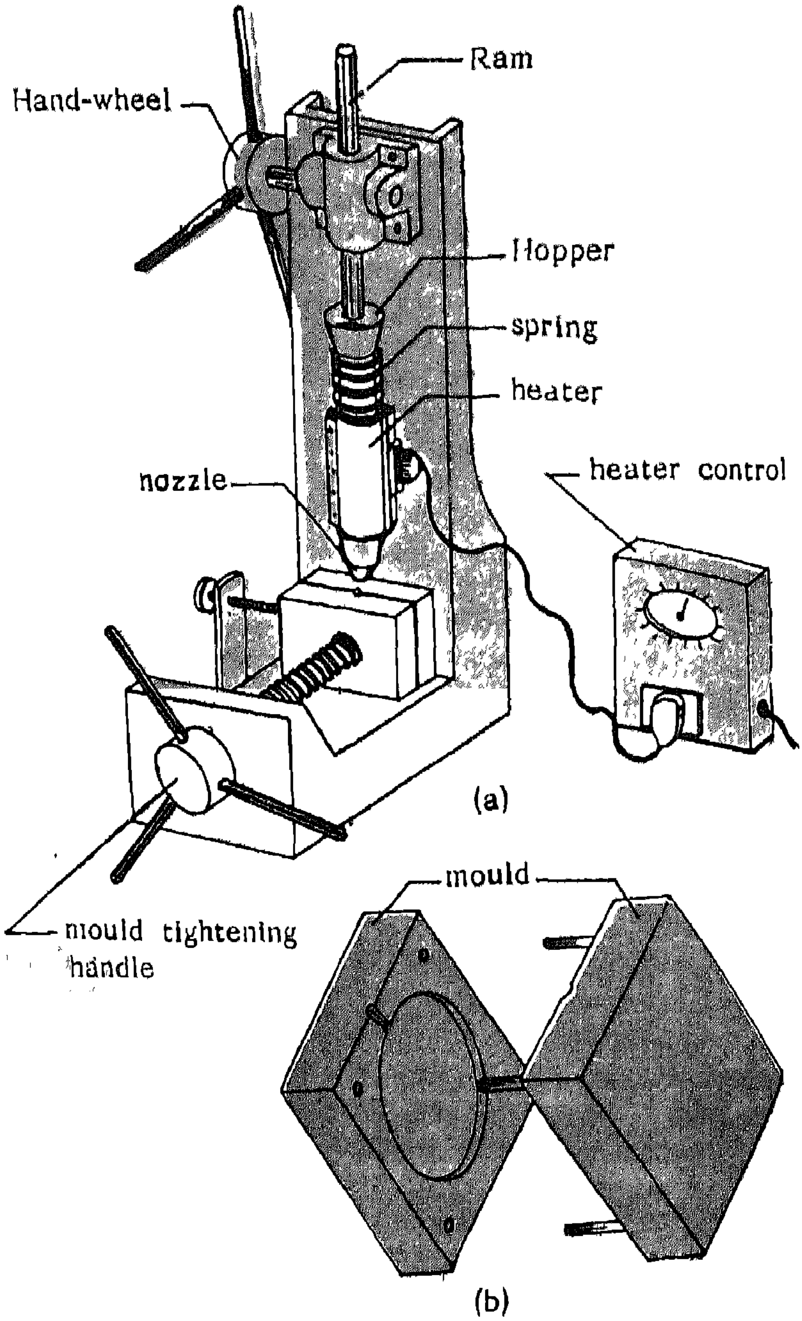


Fig 89 Manually Operated plastic Injection Moulding Machine

(i) *Manually operated plastic Injection Moulding Machine* The machine is available in various sizes e.g. 7 g, 15 g, 30 g etc. upto 120 g (Fig. 89). The price of a 7 g. machine is nearly Rs. 800/-. The mould is held between the jaws of vice. The mould gate should be in line with the injection nozzle. Moulds are made of steel, but for small machines and for a small component one may as well as try hard variety of wood as mould material, making a mould of wood will be easier Granules of plastics (say, polyethylene high density or polystyrene) are fed in the hopper These are heated in the nozzle section by electric heater. At an appropriate temperature, the granules become semisolid and then the ram is pressed on the material in the hopper by rotating the handle manually. The product is taken out of the mould which is generally in two or more than two parts.

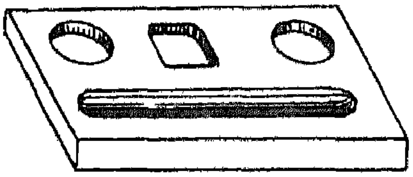


Fig. 90

(ii) *Vacuum Forming Machine:* PVC, polypropylene, cellulose acetate upto 1.5 mm thick can be vacuum formed (to be cupped according to a certain profile, examples egg rack, plastics mask, packing tray etc.). In the vacuum forming machine the thin sheet is pressed tight on the form, then is heated by the electric heater and finally the lower chamber is evacuated by a vacuum pump so that the sheet is cupped and it takes the profile of the form shown in Fig. 90.

(iii) *Fixture for bending Thermoplastic sheet:* The thermoplastics sheet is placed on the heater with bend marks positioned over the element Other technique of bending acrylic could be to heat it in an oven upto 150°C till it is soft and pliable. It is then bent as desired.

(iv) *Thermoplastics sheet cutting fixture:* Thermoplastics sheet of any thickness can be cut on this with a very smooth finish. The temperature of the nichrome wire can be varied to suit ideal cutting by operating the variable resistance. (Fig 91)

(v) *Tools and procedure for making glass reinforced plastics* Gel resin is to be prepared by adding 5% colour paste (if required). Catalyst is to be added (from 1 to 12 c.c. per kg). This resin is to be applied on the mould (its surface should

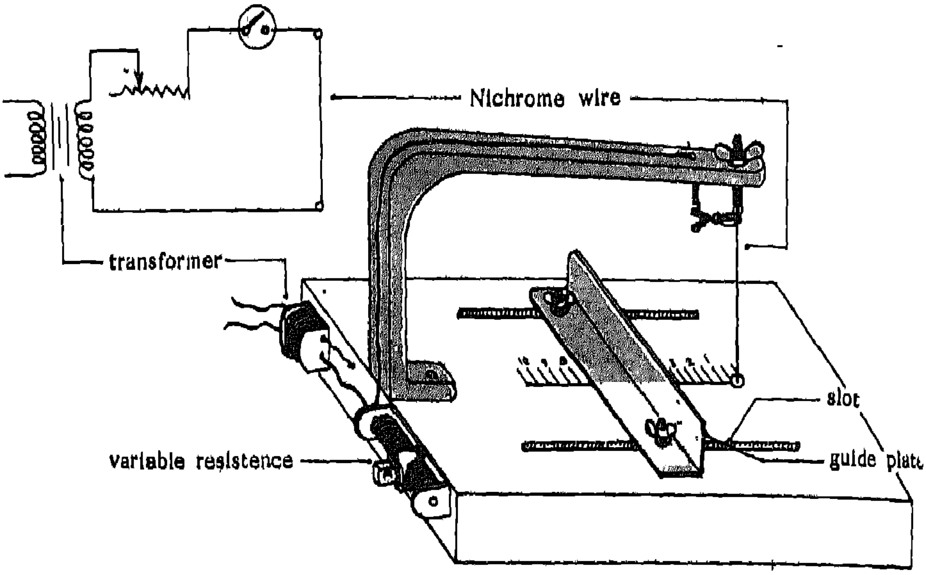


FIG. 91. Hot wire cutting for plastics

be glossy and coated with mould release wax) by brush. First layer of laminating resin is to be applied when gel coat has become thick. This takes 20-30 minutes. Now appply first layer of chopped strand matting of glass A roller should be used to roll out air bubbles. Again a layer of laminating resin is applied and a second layer of glass fibre follows. A final layer of tissue (surface layer) will produce smooth surface. The job is then removed from the mould after curing is over Edges may be cut with saw. Finishing is given to the edges by wet-and-dry paper and metal polish (Fig. 92)

(vi) Joining plastics parts Polyethylene, polypropylene and some other varieties cannot be cemented because suitable solvents are not available. In these cases adhesive may be used for joining. ICI plastics Division recommends 'Tensol' cements for use with perspex acrylic sheet. Welding two plastics by hot air is done in some cases. The following solvents are recommended for joining parts in case of some types of plastics:

Type of plastics	*Solvent*
Cellulose Acetate	Mixture of Ethyl 70 c c. Benzene 100 cc
Polystyrene	Acetone, Benzene, Trichloroethylene
Perpex/Acrylic	Acetone, Ethyl Alcohol

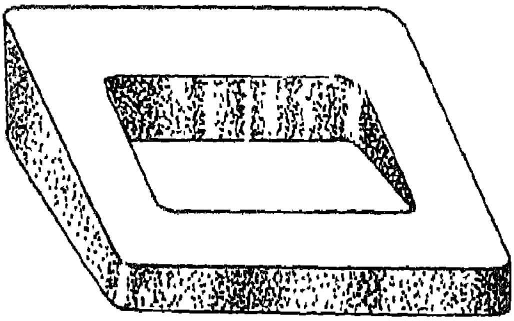


FIG. 92 Reinforced Plastics

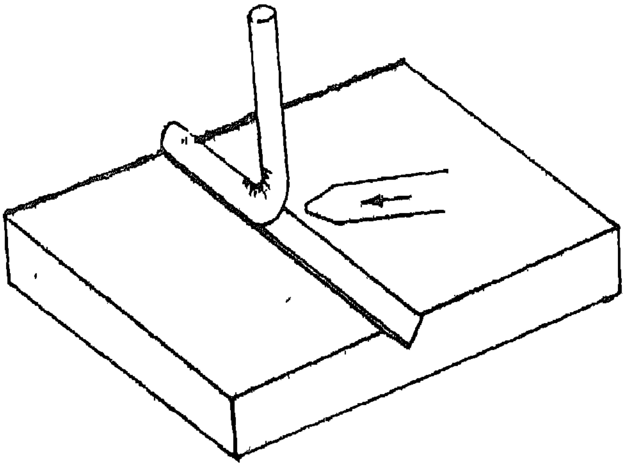


FIG. 93 Bending of Plastics by hot air

2 8 *Working with glass*

Cutting sheet glass: glass bottle, making holes on glass, edging, glass tube bending, fusing glass tube, etc. are the general operations in a school workshop.

(a) Glass Cutting

Diamond glass cutter is generally used for glass cutting; however sheet glass and glass tube can also be very well cut with the help of a sharp stone as shown. The scratch made on the glass by glass cutter or stone is the parting line

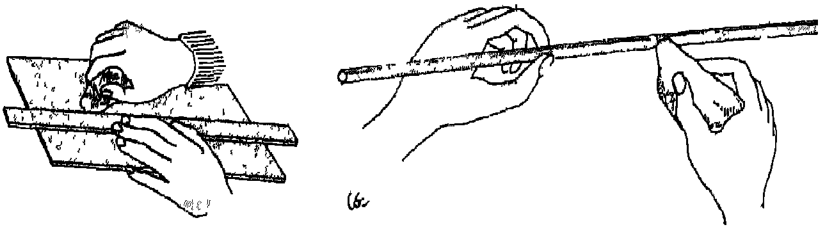


FIG. 94(a) and 94 (b) Scratching glass with a stone

(b) Cutting glass bottles

A scratch on the bottle at the desired height with the help of a diamond cutter or stone is made Pour water in to the bottle upto the mark A piece of cloth soaked in kerosene oil is wrapped on a thin steel wire which is fixed around the bottle over the scratch line by twisting the ends. Now you have to set fire to the kerosene soaked cloth The bottle will crack at the desired line uniformly. The edge of the parting line are to be ground on a grinding stone

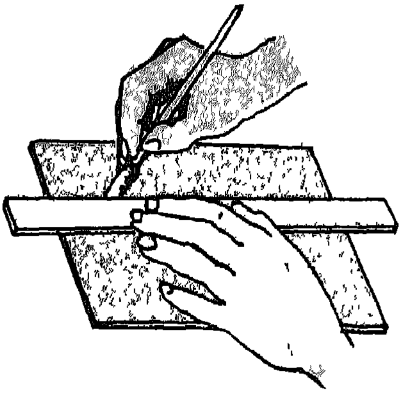


FIG. 95 Scratching glass with diamond cutter

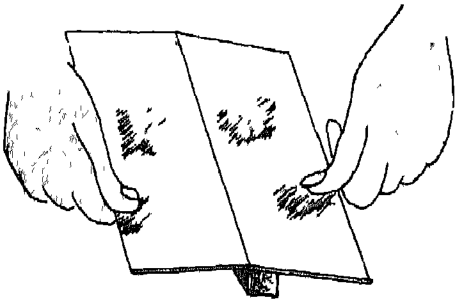


FIG 96 Breaking glass sheet in two parts at the line of scratch

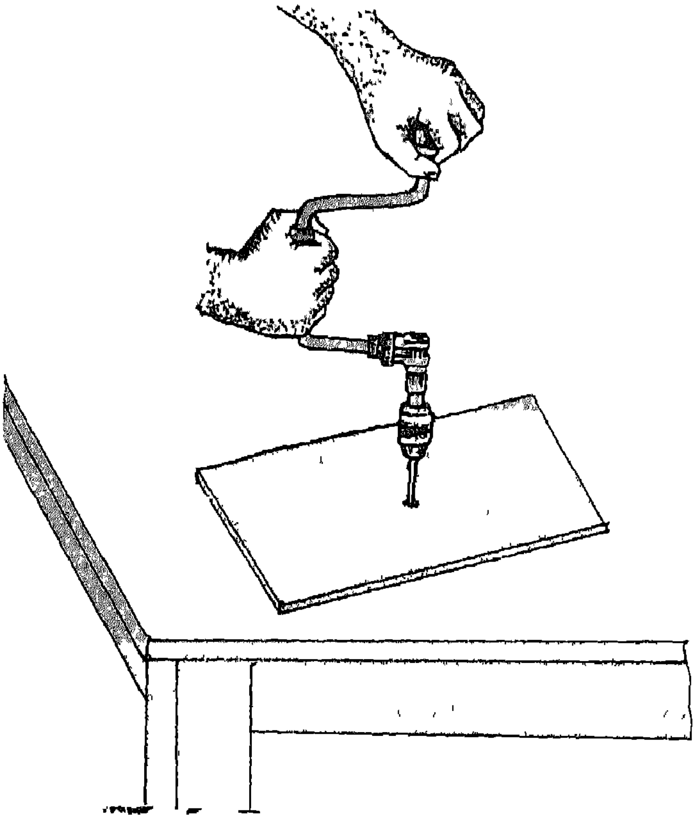


FIG. 97 Glass Drilling

(c) Glass drilling

This can be easily done with the help of a ratchet brace with a pointed broken triangular file held in its jaws. The ratchet brace is to be rotated, keeping the point of the triangular file on the desired spot on the glass sheet. Kerosene oil, mustard oil and emery powder are to be applied at the point of drilling. (Fig. 97)

(d) Glass tube bending

Glass tubes upto 6mm dia can be bent over a candle flame. However, for bending solid glass rods and bigger tubes, one has to use burners Small glass balls which are used in bead microscopes can be made by drawing solid glass rod or tube over flame manually Glass tubes of the same composition can be fused together over a flame easily

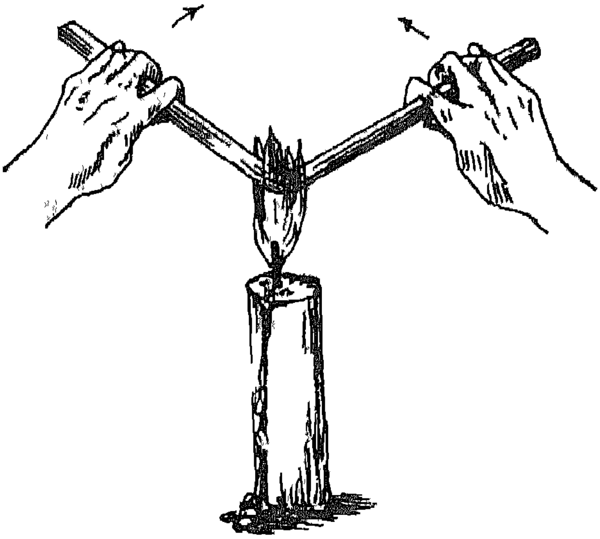


FIG 98. Glass tube bending

3. Paints

3.1 What and Why?

Surfaces of metal and non-metal which tarnish or corrode with time are covered by a thin protective layer of paint. There are also other methods to cover such surfaces e.g. electroplating, plastic coating etc. But paints cover most of the surfaces that you are seeing in your everyday life In homes paint can be seen on walls, doors, window frames, furniture etc. Outside home you see car, bus, train, ship, aeroplane etc covered by paint. It is primarily used to protect the surface against wear It protects wooden materials from rotting and metal from rusting. In ships paint fights the danger of barnacles, weeds, rust which can eat into the steel hull below the waterline

It is also an important part of decoration. Aesthetic sensibility demands pleasing colour composition We have also mental association with colours e.g red indicates danger, stop, fire. One shade of red is called 'post office red' as it is used in letter boxes everywhere

3.2. Composition of paint

A paint may be as simple as white wash, which is a simple mixture of chalk powder with water or as complex as that used on aeroplanes and cars

The constituents of a paint can be briefly summarised as follows

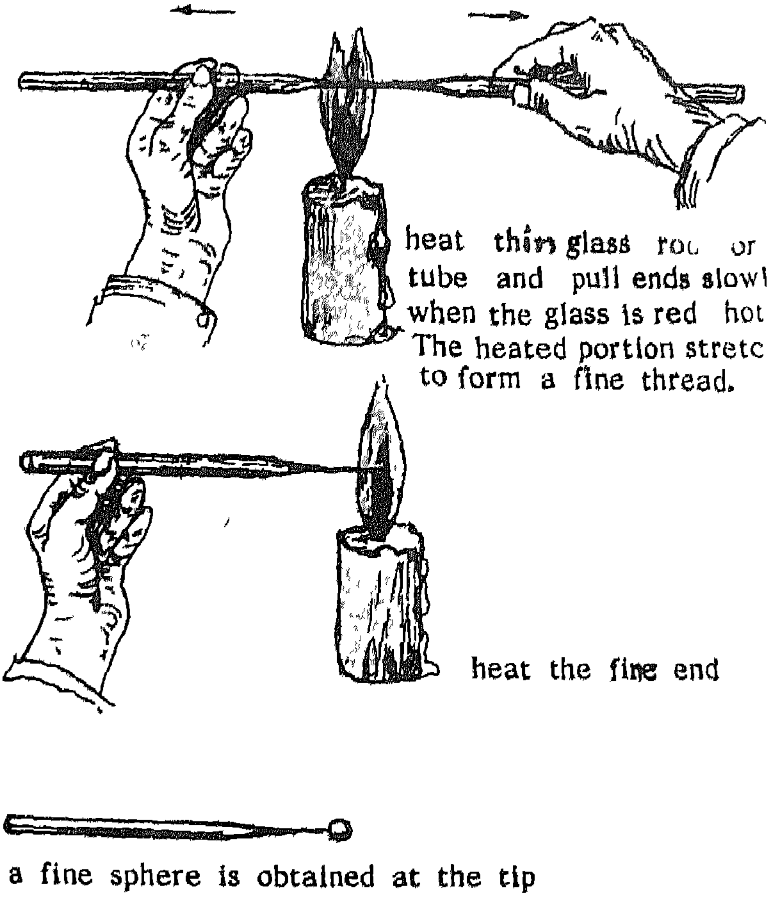

heat thin glass rod or
tube and pull ends slowl
when the glass is red hot
The heated portion stretc
to form a fine thread.
heat the fine end
a fine sphere is obtained at the tip

Fig. 99. Making glass Bead for bad Microscopes

PAINT

PIGMENT VEHICLE ADDITIVES

BINDER SOLVENT OR DILUENT

Pigment is normally a solid material in very fine particles insoluble in the vehicle. It provides the colour of the paint film. It affects the flow, gloss and durability of the paint and other properties such as corrosive resistance, fire resistance, anti fouling etc. It must remain suspended in the paint and not settle to form a hard sediment.

Pigments are also mixed with extenders which are similar to pigments though they don't provide colour or obliteration. Extenders give improved strength of the paint film and improve adhesion to the surface and reduce the cost of the product.

The common white pigment is titanium dioxide. Others are zinc oxide, lithopone (a mixture of zinc sulphide and barium sulphate), antimony oxide etc. The common inorganic coloured pigments are—iron oxide, lead chromate, chromium oxide, prussian blue, aluminium metal etc. Common extenders are calcium carbonate (chalk powder), barium sulphate, silica compounds like talc, china clay etc.

Vehicle carries pigment and constitutes the liquid portion of the paint. Its two constituents are binder and solvent.

The binder or the film former binds pigment particles together and provides cohesion of the paint to the surface. One can use it without pigment to form a clear dry 'varnish' film. It does not readily evaporate due to the presence of substances like resins, plasticiser etc. in it.

Paints take their names from the main binder ingredient e.g acrylic, polyurethane or alkyd paint. Binder gives paint necessary properties like gloss, adhesion, hardness, toughness, flexibility, durability and speed of drying.

Solvent or diluent is the volatile material with which the binder and pigment are mixed. It determines the correct consistency of the paint for being applied to the surface by brush, spray or dipping or any other method

The paint is sometimes required to dry more quickly or flow out evenly to remove brush marks or to stop skinning in the can. *Additives* are necessary to bring in one or more such properties. Silicone is one additive which makes the surface of the paint film more resistant to marking and scratching. Non-drip paint have additives which make them 'thixotropic'.

3.3. Drying speed of the paint is a very important factor. An important type of paint commonly known as lacquer, has resin dissolved in solvent. The solvent evaporates and the resin constitutes the protective film. Example: nitro-cellulose lacquer which is used as 'touch up' paint for cars. It is quick-drying in all weathers and polishes easily. Another type is emulsion paint in which the vehicle consists of small particles of vinyl resin dispersed in water. When water evaporates, the resin particles coalesce (combine) to form protective film.

Decorative gloss paints based on alkyd resins dry by chemical reaction. Firstly the solvent evaporates to form the film of pigment and binder. Then there is a chemical reaction among oxygen (air), polymer and the film. Due to this the sticky liquid changes to a plastic solid.

Drying by chemical reaction is also the principle of painting cars in the factory These paints are based on acrylic and melamine formaldehyde resins. When the solvent has evaporated after application of the paint, the film is heated by suitable means such as stoving in an oven or by infra-red lamps. Higher temperature is required for chemical reaction. Result is a hard insoluble film.

How do you propose to apply paint on a metallic part - by brush, spray, dip?

- What happens if you paint on a Trusty surface?
- What type of surface preparation one has to make for good adhesion?
- Do the steel and the paint film on it have the same coefficient of expansion? What could be effect of temperature on the pair?
- What could be the ideal property of the paint film so that it does not easily crack or flake?
- Light, water and air are the attackers. Have you noticed stages of deterioration of a paint on a surface? If so, what are the stages?

3.4. *How will you paint your exhibit?*

Painting is the finishing or last operation in your case. Paints in sealed tin containers are available in hardware/ paint shops. No special set up is necessary. for painting with brush. You can do it yourself on the lines of following steps and details.

Surface preparation

(a) For metallic/wooden surfaces other than wooden furniture.

Surfaces are first made smooth by sand paper (for wood) or emery paper(for metal) The voids on the surfaces are filled up by *putti* (available in packets in the shops dealing in paints). You can also prepare putti by mixing chalk powder with varnish (1 kg: 250 g). Add water to make a paste. Commercially NC putti (for lacquer paint) and oil glazing putti(for synthetic paint) are available When the paste in voids/discontinuities on surfaces dry up, the surface is again smoothened by sand/emery paper. In case of iron & steel surfaces, *primer* paint is applied so as to fight rusting and to make the life of the final paint coating long.

(b) For wooden furniture

Add glue *(chapra saresh)* to boiling water and then yellow earth *(peeli meeti)* in the ratio of 100g (glue). 250cc (water) 1 kg. (yellow earth). The paste is used for preparation of ground surface.

Given below are proportions etc. for simplest application

Name of paint	Solvent	Ratio paint: Solvent	Where to be used	Facilities/tools required while painting	Remarks
1. Synthetic enamel (including hammertone approx. Rs. 80/-per litre	Turpentine (approx. Rs. 10 per litre)	1:5	All metals, wooden surfaces.	Writing brush (No. 0-10) Paint brush (sizes 25-90 mm), sand paper, emery paper, old dhoti, one or two cans (or containers/ with wide mouth) to mix paints with solvents, air compressor with spray equipment, etc.	
2. Spirit polish	Spirit (Rs. 13 per litre)		Wooden furniture		Spirit and lakdana are mixed (1 litre: 250 g) and then applied on the prepared ground surface with the help of a piece of cotton cloth
3. Varnish polish	Synthetic varnish (Rs. 10 per litre)		Wooden surfaces		

4. Adhesives and sealants

For joining wood to wood(including plywood, hard board etc) and sunmica sheet to wood, various synthetic resins are popular in the market e.g. Fevicol, Mowicoll, Plycol etc. A thin film of such adhesive is applied on both the surfaces to be joined. Wait for 10-15 minutes and then join while they are tacky and hammer lightly The surfaces that are smooth or slippery should be roughened before applying adhesives. 'Quick Fix' and similar other synthetic adhesives are popular in the household for cementing crockery, glassware, plastics, jewellery, toys etc. 'Araldite' (adhesive and hardner) is another popular adhesive which can render the joint sufficiently strong provided the mating sufaces are properly cleaned and these are held in position (after application of the adhesive) under load for a maximum period of 24 hrs. Such adhesive practically joins everything. Varieties of rubber solution (trade names - 'Solfix', 'Super fix', 'Griptite' etc) are very popular for bonding leather, rubber, foam, clothes, shoe lining, sunmica, wooden and rubberised floor tiles, ceramic tiles, carpets etc. These adhesives are applied on both mating surfaces after cleaning the same. You are to wait for 4-5 minutes for the adhesive to dry. The rubber solution is also used for mounting pictures etc. as detailed in section 11 of Chapter IV All these adhesives have one limitation, they cannot generally withstand temperatures much beyond 50°C.

Engineering adhesives and sealants consist of anaerobics, cyanoacrylates, epoxies, rubber based adhesives, silicone sealants and liquid sealants. These are being used in automobiles, air conditioning & refrigeration, pumps, motors, etc. The properties of each are given below.

(a) *Anaerobic*—it is a single component room temperature curing liquid or paste for metals/non-metals. It is the best sealant It hardens in the absence of air. It fills gaps upto 0.15mm and seals pressure upto 400 kg/cm^2.

(b) *Cyanoacrylate*—it bonds plastics, metals and rubbers. No mixing is required and it sets within seconds.

(c) *Epoxy*—it joins anything to anything (as in 'Araldite')

(d) *Rubber based*—synthetic rubber adhesive develops a bond between two surfaces which is flexible and resistant to oil, alkali, water, petrol etc.

(e) *Silicone sealant*—it is a ready-to-use one component adhesive/sealant paste which cures at room temperature by reaction with moisture to form a tough and rubbery solid.

(f) *Liquid sealant*—it has medium high viscosity and on evaporation forms a semi drying, elastic film which withstands temperature upto 140°C and is resistant to oil and water.

5. Plasticraft

Our potters, weavers, craftsmen made significant contribution to our civilization. Bronze casting in India is as old as our civilization. Bronzed perfection in idols of Ganesh (chamba), Nagdevi (Bastar) equestrian gramadevata (Bastar) Mahishasuramardin (Tenali) etc. are the expressions of the artist firstly on a lump of wax.

You can give shape to your creative ideas with the help of wax, papier mâché, modelling clay, plaster, polyester resin, plastic film. These materials are inexpensive; some of them can even be collected from scrap.

a) Paraffin Wax

Among others wax is used for casting bronze in the universal method *'cire perdue'* or lost wax process To start with you should try to cast candles from paraffin wax Making candles is the most safe and common use of paraffin wax.

Tools and materials required· glass sheet, granulated or slabbed paraffin wax, stearin, wax dyes(powder or solid form), mould seal or plasticine, wick, knitting needles, sauce pan etc. A hollow pipe (bore and length of which should correspond to candle dimensions) of glass or plastics may be taken and used as mould. For better results, inside of the mould should be brushed with white or fine silicone spray. The wick which passes through a hole in the bottom of the mould is held along the mould axis with the help of cross needles.

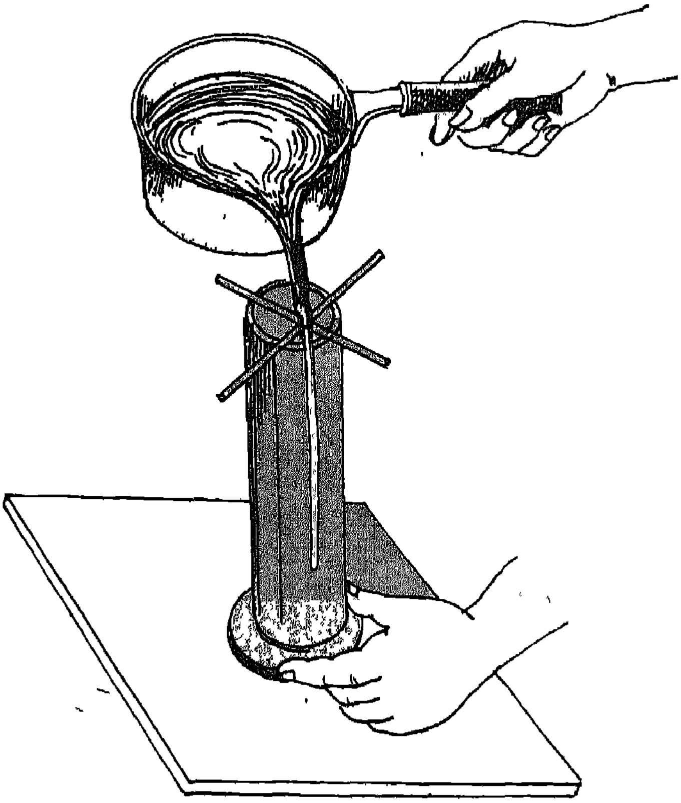


FIG. 100. Casting Candles

Paraffin wax and stearin (1:3) are gently heated in a pan. It should never be allowed to boil and should not be heated over a fierce flame A little wax dye is added and mixture is stirred well. The pouring of wax is shown in the Fig. 100. If you want your candle to burn with an even non-smoky flame, dip the wick into a two per cent solution of boracic acid. The moulded candle may be polished with ammonia or alcohol

Wax buds of different colours are used to replicate fruits, flowers etc. This is done by dipping a cotton-bud-on-brass wire in molten wax of desired colour Small container having wax is placed in boiling water as to have molten wax at more or less constant temperature. It is possible to make model of flower petals with the help of wax In this case a thin layer of wax of desired colour is spread first on a glass sheet and the desired profile is cut.

In replicating work, wax can do wonders. Wax statue looks so natural that the viewer sometimes can't differentiate it from the original.

Can you think of replicating (to a reasonable scale) a thick forest? You may use dark green, light green and other appropriate coloured wax, pieces of expanded polystrene, cotton wool, brass/aluminium wire, etc. Sketch the scheme first, arrange moulds and make it.

(b) Modelling Clay

Tools and materials. modelling clay (natural or synthetic), kitchen knife, plastic vessel, wire loop tool, chisel, wooden board or glass sheet

Modelling clay is available from craft shops It is very easy to handle when it is moist. Its hardness, chemical composition and colours change at the baking (biscuit fire) temperature of 750°C to 900°C. After baking it is glazed to obtain shiny and water proof finish.

A temperature between 950°C to 1000°C is required for glaze firing. If you do not have the facility for firing or clay modelling you may take it to a potter.

Plasticine is useful for making small experimental models; it can be used over and over again. It also remains soft. There is a variety of modelling clay which dries up and hardens at room temperature. This is required in cases where finer details are necessary

This variety of clay requires some mild heat treatment in a domestic oven at 180°C.

Clay modelling is very useful for making plasticraft of useful specimens. Clay model of the specimen is first prepared by impression of the original on modelling clay. Liquid plaster is poured on this. The dried negative is finished with the help of knife, brush etc. For easy removal of the plaster negative, talcum powder is spread beforehand lightly on the modelling clay.

(c) Papier Mâche

Papier mâché is used for making different types of profiles, masks etc. *Tools and materials;* glue or paper paste, small round brush, block of expanded polystyrene, liquid wax, short knife etc.

Polystyrene block is first carved in the desired profile. The profile can otherwise also be made from clay, plaster etc. The carved surface is painted with a layer of liquid wax. Now this is covered with small scraps of shredded newspaper soaked in water Six or eight such layers dipped in glue or paste are applied.

This is dried for two days and then the papier mâché layer is taken out (may be cut suitably at convenient section in particular cases). The dried mask is then finished with fine sandpaper and painted with white acrylic paint. Paint and varnish are applied subsequently.

(d) Plaster

Tools and materials required: Plaster, large spoon, plastic tumbler, moulds, cooking oil, paint brush, paint, knife, galvanised iron wire, sheet of glass, coarse jute cloth, plaster bandage, vaseline, aluminium foil, scissors, paint, polyurethane varnish, fine wire wool, flat nose pliers, sandpaper etc.

Casting plaster such as plaster of paris, superfine dental plaster, plaster bandages are generally used in work involving plaster. Water is always added to plaster and the mixture takes 15 to 20 minutes to set. If the proportion of water is decreased it sets rapidly and becomes strong and hard. If the process is to be slowed down, borax could be added to water. Borax, water and plaster of paris may be mixed in the proportion of half teaspoon : one glass : one-and-half glass of plaster. Very high proportion of borax will prevent the plaster from setting at all.

If you cast on a sheet of glass lightly surfaced with oil, the cast plaster will have a smooth finish. Rough casting can also be smoothened by abrasive paper. Plaster casting can be repaired with modern glues. The casting can be lacquered or painted.

Suppose you are to prepare statue of a man on pedestal. Skeleton of the man on pedestal is first made of galvanized wire (Fig. 101). Gunny cloth to hold plaster is then wrapped on the skeleton. Then layers of plaster are applied and a rough shape is given. Finally use knife for scrapping and finishing before the plaster has set. Paint all surfaces after it has dried up after three days.

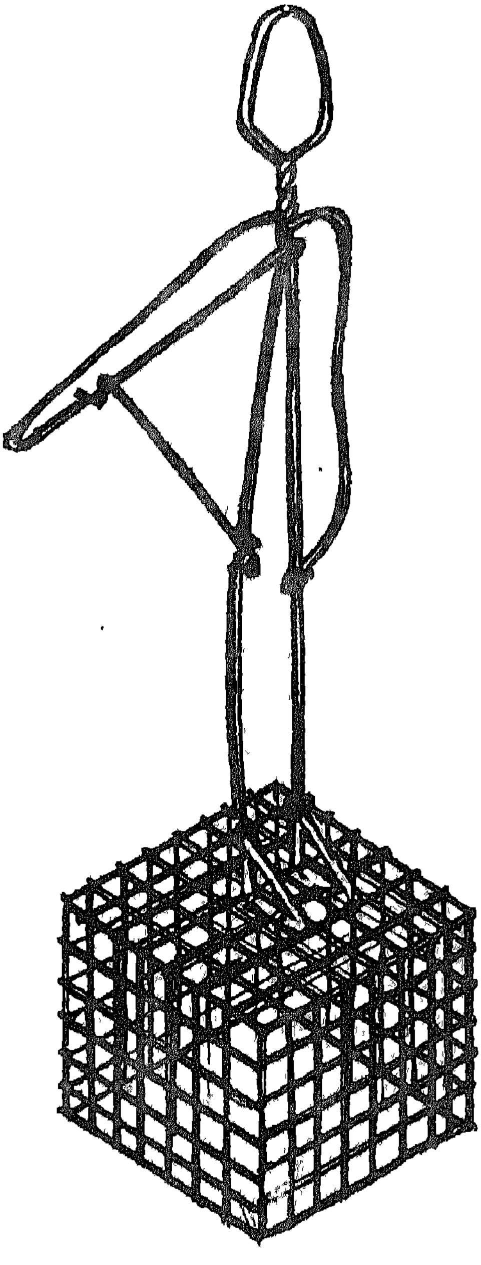


FIG 101

Replica of any object may be made by plaster cast. Atomic structure, packing of crystals, cells, etc. can be made effectively. Replica of an object of archeological interest may be prepared directly from the original. Even a face mask can be made very effectively by this method. The original model face is to be first covered with a layer of vaseline The model should be placed horizontally (on the ground) Soak the plaster bandage in tepid water for five or six seconds; wring out the excess water carefully, unroll the plaster bandage to cover the face smoothing out each layer of bandage with paint brush If you are making mask on somebody's face, eyes need be closed and the nose need be left while applying the plaster bandage The mask is then left to dry for approximately 24 hours Subsequently varnish it with 3 or 4 layers of polyurethane varnish or paint.

(e) Polyester Resin

Tools and materials· preactivated polyester resin, catalyst (hardner), glass or polyethylene measuring beaker, stirrers, small pieces of polyester film etc. The mould could be made of polyethylene, polypropylene glass, metal or wood. Read the instructions of manufacturer of the polyester resin

Transparent casts are made in any shape from polyester resin which is available in liquid form. A few drops of hardner (catalyst) to the resin will change it to jelly like semi-solid and finally into a hard transparent substance This process is called polymensation. There is considerable rise in temperature during this reaction. Curing occurs at room temperature. The resin and hardner are inflammable when liquid and these are not to be used near a fire or open flame. Resin can harm your skin, so use gloves or apply barrier cream In case of any contact with you skin, wash it immediately with warm detergent water. If the hardner gets into eyes, immediately wash your eyes in clean tepid water. Open space (and not a room) should be used for working with polyester resin so that hazardous fumes don't affect you.

Try to remove air bubbles as far as possible while mixing If an item requires several pourings of resin, each layer is to be added in quick succession otherwise there will be surface marks between the layers. If heat produced during mixing is excessive, the polymerisation process should be slowed down by dipping the container in cold water.

We can mount the object of interest (dead insect, fossil, coin etc). by the method shown in Fig. 102.

A permanent and ideal herbarium can be made by embedding pressed flowers and leaves in resin. Firstly a polyester film is placed on a sheet of glass and is covered with a piece of small glass-fibre mat For covering an area nearly 1500 sq cm, 40 g. of resin together with the proportionate quantity of hardner will be required. A thin layer of resin mix is spread on the fabric The plants (Fig 103) are placed and another thin layer of resin is applied Now the entire surface is covered with the second sheet of polyester film. Now roll a cardboard tube over the polyester film to force out air bubbles. After the resin has hardened, the sheets of polyester

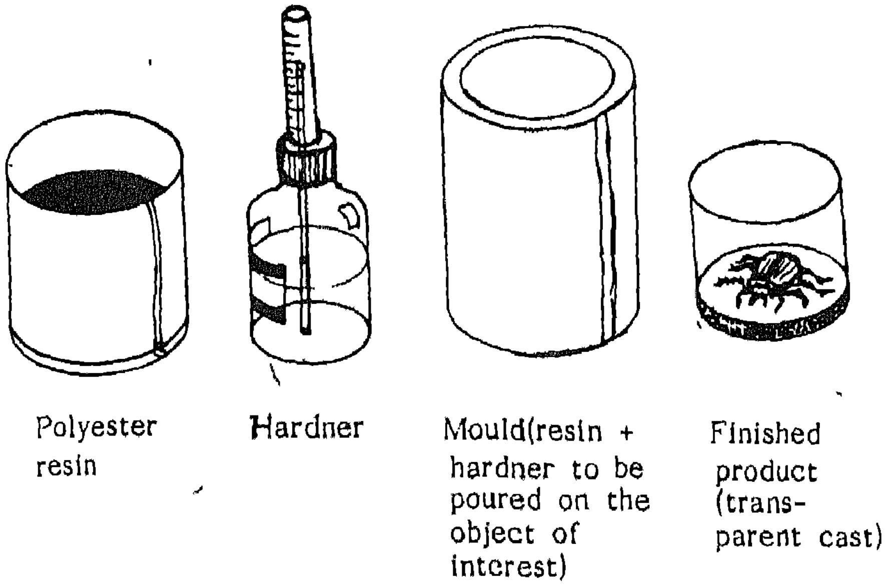

Polyester resin
Hardner
Mould(resin + hardner to be poured on the object of interest)
Finished product (trans-parent cast)

FIG 102. Transparent Casts from polyester resin

FIG. 103

film are removed The outer edges of the herbarium is finished with scissors

Varieties of geometrical shapes in three dimensions with different variations like colours, embedding etc., can be produced out of resin. For example, hollow cubes of various sizes are made out of transparent cellulose acetate sheets, transparent or coloured resin cubes are cast in these moulds in the same manner as explained in Fig. 102.

Similarly any three dimensional object i.e sphere, cylinder, prism, cone etc can be prepared out of polyester resin.

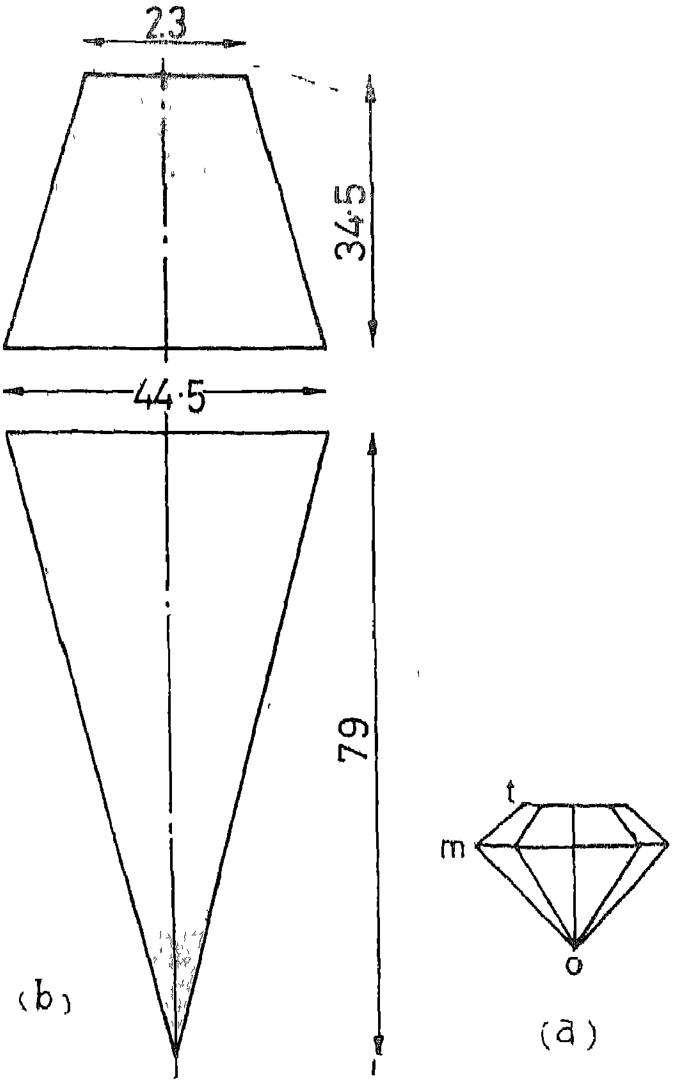


Fig 104

You are to cast the replica of a diamond shown in Fig. 104 There are eight isosceles triangles (base 44.5 mm x height 79 mm) meeting at point O There are eight trapezoidal surfaces (base 44.5 mm /23 mm x 34 5 mm height) between planes m and t. Think of a mould made of acetate sheets in which this diamond will be produced out of resin casting Sketch the mould first with dimensions and then prepare it.

(f) Plastic Film

Tools and Materials: Brass wire, small flat nose pliers, tin of plastic varnish, round nose pliers, fishing thread etc.

If a metal wire bent in the form of a circle or square or any profile is dipped into coloured plastic varnish, a film of colour is obtained. The film takes up the contour of wire frame and looks delicate and attractive. The bird-wings shown in Fig. 105 is a typical example. By using various profiles and colours artistic and decorative objects may be made i.e. wild orchid, thorn sculpture etc

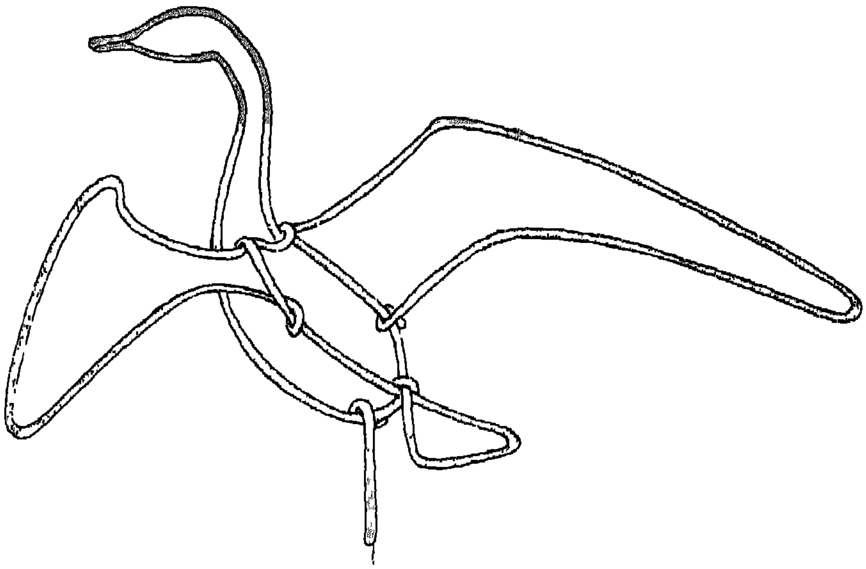


FIG. 105

Sketch the replica of a spiral way (with a pitch of 50 mm) going to the hill top. Design a supporting structure of brass wires, which when dipped in plastic varnish, will form the spiral way

6. Aero and ship modelling, engines, radio control materials etc.

If you have already such hobbies or you have a strong desire to work on those, the following will help you to overcome initial hurdles of selection and procurement. These are available with special shops dealing in hobby materials, toys etc

Items 1	*Specification* 2	*Approx unit price* 3
Ready to Fly models Fun/Fighters		Rs P
Jap Zero	11" Multicolour chuck glider	20 00
ME 109	11" Multicolour chuck glider	28 00
Spitfire	11" Multicolour chuck glider	28 00
Mustang	11" Multicolour chuck glider	28.00
Interceptor	Snap folding wing/catapult	50.00
Rubber Models		
Chaster	20" readymade for beginners	56 00
Bobni	13" kit for beginners	13 00
Babix	18" kit for beginners	22 00
Mentor	32" competition kit	100 00
Chuck Gliders/Kits		
Tiny Tot	11" beginners	22.00
Tich	9" beginners/Competition	13 00
Sail-a-way	15-3/4, cabin type	44.50
Philadelphian	6" beginners/competition	11.00
Catapult Glider Kits		
Yellow Bird	13" Competition	33 00

1	2	3
Falcon	14" Competition	33.00
Sparrow	Competition	50.00
Gnat	12" Semi-scale jet fighter	26 00
Hunter	14" Semi-scale jet fighter	28 00
Marut	14" Semi-scale jet fighter	28 00
Mig-21	13" Semi-scale jet fighter	27.00
Harrier	Falkland war jet fighter	28 00
Jaguar	Semi-scale jet fighter	31.00
Mig-25 Box Bat	3 D type semi-scale jet fighter	50 00
F-16	Auto elevator semi-scale jet fighter	50.00
Tow-Line Glider Kits		
Magpie	24" for beginners	50.00
Gnome	32" robust model for beginners	72.00
Martin	40" for beginners	94 00
La-mouette	48" intermediate model	133 00
Lucifer	75" competition/duration	194.00
Inchworm	64" competition/duration	166.00
Free Fight Models	**RATES WITHOUT ENGINE**	
Tom Boy	36" cabin type (beginners) 75cc	122.00
Magna	38" cabin type (beginners) 75cc	128 00
Cessna 150	Stand off scale 75cc	139.00
Pushpak	37" Stand off scale 75cc	194.00
Y-Bar	40" Competition/open power ratio 1 5cc	178 00
Eureka	50" Competition power ratio 2 5-3 5cc	173 00
Swiss Miss	58" Competition 2.5-3.5cc	194 00
Max factor	46" Competition power ratio 1.5-2.5cc	160.00
Eliminator	45"Competition power ratio 1 5-2 0cc	139.00
Control line Kits		
Tyro	17" Trainer 0.75cc	83 00
Sky Bee Medium	24" Trainer 1.5cc-2.0cc	100.00
Sky Bee Senior	29" Trainer 2.5cc-3.5cc	122 00
Mini Sugah	25" Trainer tricycle undercarriage 1 5cc	105.00
Sky Sugah	30" Trainer tricycle undercarriage 2.5cc	133 00
Bunt Maker	24" Elementary Aerobatics 1 5cc-2.0cc	105.00
Marvin	30" Aerobatics 1.5cc-2.0 cc	133 00
Great Guns	35.1/2" Advanced Aerobatics 2 5-3.5cc	166.00

1	*2*	*3*
Peacemaker	35.1/2" Advanced Aerobatics 2.5-3.5cc	166.00
Silver Arrow	37" Advanced Aerobatic 2.5-3.5cc	200.00
Aerobat	38" Advanced Aerobatic 2.5-3.5cc	194.00
Magic	38" Advanced Aerobatic 2.5-3.5cc	178.00
Radio Control Kits	**RATES WITHOUT ENGINE**	
School Marm	40" 2-channel trainer 2.5cc	277.00
Miss world	47" 2-4 channel trainer 3.5cc-4.5cc	415.00
Miss world Deluxe	47" 2-4 channel trainer/Imported parts	700.00
Cessna 152 Aerobat	3 Channel trainer 2.5cc-3.5 cc	360.00
Cessna Centurion	3 Channel scale trainer 2.5cc-3.5cc	360.00
Citabira	Scale type 2-4 channel 2.5cc-3.5cc	415.00
Miss Universe	47" 4 channel aerobatic 5cc	470.00
Sport fly	39" 2-4 channel 2.5-3.5cc	305.00
Aeronca sedan	65" scale trainer 2-4 channel 2.5-3.5cc	500.00
Orange box	79" Glider 2 channel 1.5-2cc	470.00
Screaming Hawk	79" Glider 2 channel	470.00
Orange box Mix II & III	79" High performance with power pad 2-3 channel	500.00
Gnat	7" wing span	72.00
Mig 21	12" wing span	83.00
Kiran	14" wing span	89.00
Ishkara	12" wing span	83.00
Jaguar	7" wing span	72.00
Ship Models		
Mite	13" length 4" beam motor Launch	95.00
Smite	15" length 4.1/2" beam motor Launch	106.00
Circle	Mine Hunter Motor Launch	250.00
Ranger	91.5cm.long Furrosted type	450.00
Marina Yacht	Free Sail Yacht .	545.00
I.N.S. Godawari	74 cm. long (motorised)	300.00
Diesel Engines-Power	**RATES WITHOUT PROP**	
K 75	.75cc	360.00
K 130	1.30cc	415.00
K 150	1.5cc	390.00
K 150 R/C	1.5cc	445.00
K 200	2cc	449.00
K 200 R/C	2cc	500.00

1	2	3
K 250	2.5cc	485.00
K 250 R/C	2 5cc	525.00
K 250 B/B	2 5 cc Twin ball bearing	640.00
K 350	3.5cc	540 00
K 350 R/C	3.5cc	585.00
K 350 B/B	3.5cc Twin ball bearing	695.00
Radio Control Unit: Digital Proportional		
2 Channel set		4155 00
3 Channel set		
4 Channel set		6815.00
5 Channel set		
6 Channel set		9475 00
Aero Accessories		
Motor D C.	1.5 to 4 5 volts	20-00
Clevises	Nylon (per pair)	5-00
Control line handle	Wooden ordinary	15-00
Control line handle	Wooden reel type	42-00
Control line handle	Metallic adjustable	34 00
Control line wire	Two strand 35 m. long	21.00
Control line wire	Three strand 35 m. long	27.00
Propeller	Nylon 7" x 5" Static balanced	18.00
Propeller	Nylon 8" x 6" Static balanced	20.00
Propeller	Nylon 9" x 6" Static balanced	22.00

7. Electrical and Electronics Projects

If you have already some background in electronics, this section will help you to:

Wire simple circuits quickly
Identify different types of resistance, capacitance, relay, LDR, thermistor, switch, cell transistor, IC motors etc.
Try new circuits from books, magazines and wire them.
take up projects on electronics display.

If you are yet to experience the joy of working on electronics this section will help you to

Train yourself when you take up the very first circuit (Fig. 106) under the guidance of your teacher.
Identify tools and instruments and use them

7 1 Basic Circuits

For attempting any electrical and electronics project, basic understanding of circuit is essential. Let us take a very simple circuit with battery, bulbs and connecting wires. (Fig 106)

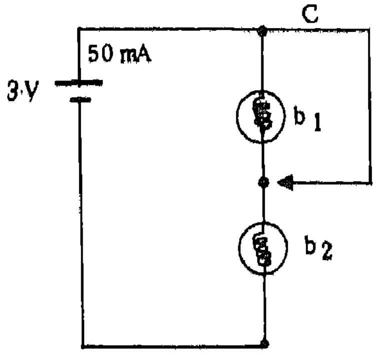


FIG. 10

First prepare the circuit on the solderless circuit board (Fig. 107) that you have already fabricated as an exercise in Chapter III.

A few review questions are given below. If you are not sure of the answers, take help of your teacher.

- Refer to Figs. 106 and 107
- Do you know the meaning of A.C, D.C, EMF, Volt (V) Ampere(A), mA, ohm (Ω) Farad(F), MF, Henry (H), Ampere turns ?
- Whether any energy conversion is happening in the circuit.
- What is the direction of electron flow ?
- What is the voltage across each of the identical lamps?

$$\left[\ \underset{\text{(Amps)}}{\text{Current}} = \frac{\text{p.d. (volt)}}{\text{Resistance (ohm)}}\ \right]$$

—What do you mean by 'series' and 'parallel' circuit with reference to Fig. 106 & 107.

—Can you calculate the resistance and power of each lamp ?

[power (Watt) = Voltage x Current
= $(\text{Current})^2$ x Resistance]

—If a thick copper wire C is connected to short out b1, what will happen to the illumination of b1 and b2?

—No switch has been used in the above circuit; do you thin a switch is necessary?

—What are the material and specifications of the connecting wires?

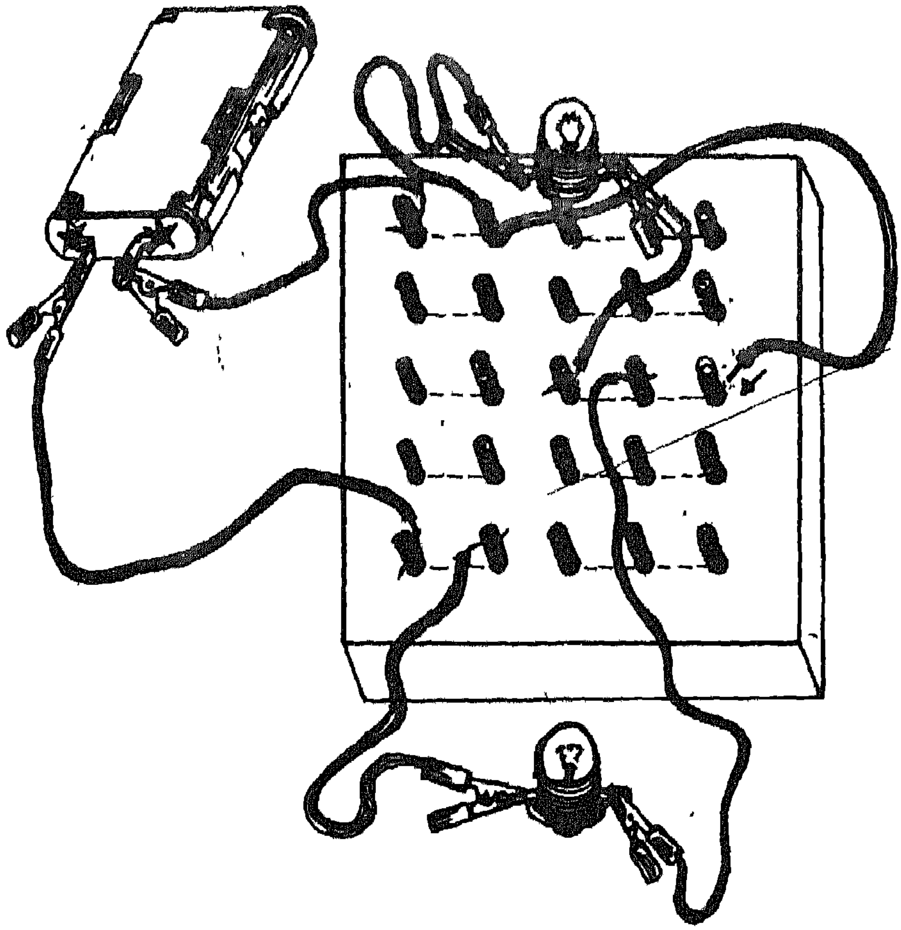


FIG. 107

Electrical energy is commonly used in exhibits:

—from A C. mains at 230V or lower voltages (through step down transformers).

—from A C. mains through a power supply which produces low voltage D.C. supply.

—from batteries

Electrical energy is consumed in lighting lamps (light & heat energy), driving loudspeaker (sound energy), operating electric motor (mechanical energy), switching a relay (electromagnetic energy), etc. A 100 Watt lamp dissipates 100 joules/second. Energy of 10 joules is required to lift 1 kg through 1 metre.

—How many joules of heat energy does a 20 Watt soldering iron produce in 15 seconds ?

—How many hours could one operate a 40 Watt record player to 'use up' 1 kWh.

—How much electrical power is dissipated in a resistor of 1 k ohm when a current of 10 mA flows through it ?

Don't move to the next section till you have satisfactorily answered all review questions of this section.

7 2 *Basic Components*

(a) Resistors: Resistors have power ratings of 1/8, 1/4, 1/2, 1 Watt and upwards. Moulded carbon and metal film resistors are used for low power application (less than 1 Watt) while variable wire resistors are used for high power applications. Generally low-power (1/4 Watt and below) resistors are required on the circuit board or bread board.

Check whether you are conversant with these:

—wire wound resistor

—moulded carbon resistor

—variable resistor (potentiometer)

—carbon-film, metal-film, metal oxide resistors

—resistor colour code

—'preferred values' of resistors

(b) Capacitor: A capacitor stores electric charge and has 'capacitance' which is measured in 'farads'. The value in farad and working voltage are marked on the body of the capacitor.

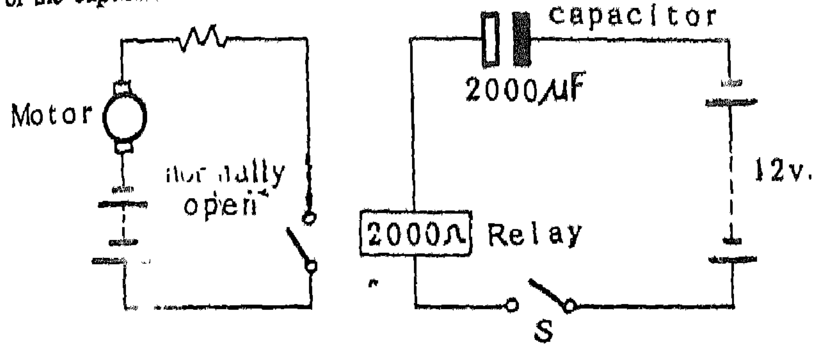


Fig. 108

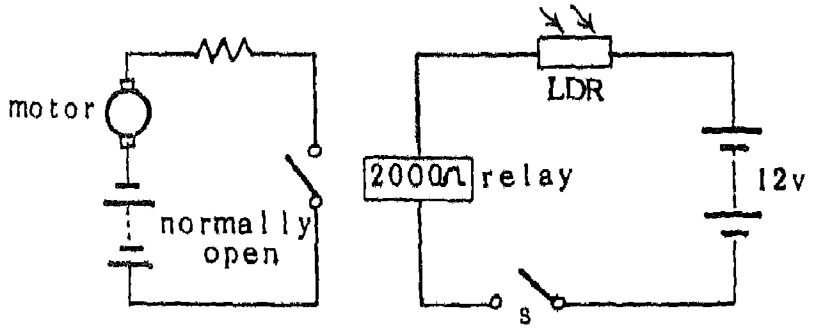


Fig. 109

You are to choose the suitable one from the types given in ascending order of farad values: silver, mica, polystyrene, ceramics, vane type solid dielectric variable, vane type air dielectric variable, polyester, polycarbonate, tantalum, electrolytic capacitor. Whereas the silver mica type has a typical range of 1 pf to 10,000 pf, the electrolytic type has 1μF to 150,000 μF.

A circuit with a capacitor, relay and battery is given in Fig. 108.

The relay (electromagnet) switch which is 'normally open' is energised by discharge current of a capacitor and closes; after a few seconds the relay switch opens again and so on.

- —If S is closed what is the peak current in the circuit?
- —Will this current fall or rise subsequently?
- —What is the time constant (C × R) in seconds?
- —Note the time (seconds) after which the relay will switch off
- —Differentiate between relay current and holding current.

(c) Special resistors, other components: Resistance of the Light Dependent Resistor (LDR) decreases with the increase of intensity of illumination of light. In the circuit given in Fig. 109 a relay operates a motor or a lamp depending on the intensity of light on the LDR. A current of magnitude 30 mA will make the relay close, *(d)* A thermistor is a temperature dependent resistor. You can make your own thermometer as per the circuit given below: (Fig. 110)

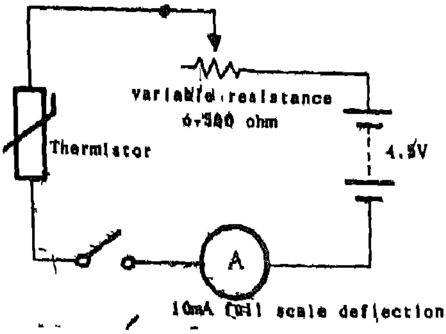


FIG. 110

Dip the thermistor in an oil bath Measure the temperature of the oil bath with a standard thermometer and note the reading of the ammeter corresponding to the temperature shown by the standard thermometer.

- Are you aware of all types or switches and their uses ? If not find out their names, designs, characteristics etc.
- List all types of cells, their ampere-hour, volt, size, places of application etc

(e) *Motors* · You should also have knowledge of the available FHP (fractional horse power) motors. You perhaps can't do without a motor or engine in a working model where movement is continuously required. The motor which runs on electricity, will be the prime mover for other motions. A list of FHP motor specifications is given below in Table 2.

7.3 Semi-conductors

If you understand the difference between a *conductor* and an *insulator*, consider the resistivity of a semiconductor to be lying somewhere between the two limits. Transistors, germanium and silicon diodes, zener diodes, tunnel diodes and metallic rectifiers are semiconductors. They have replaced vacuum tubes. "Chip" is an integrated circuit containing circuits comprising of transistors, resistors, capacitors and other elements. Chip is the marvel of microminiaturisation and landmark of high technology.

(a) Diode 'allows current in one direction and is used in logic circuits (e.g. AND, OR etc.), half wave and full wave rectification etc.

TABLE 2. **FHP Ac motor for general use**

H P.	*R.P M.*	*Price (Rs)*
1/15	900 (T)	930.00
1/11	900 (S)	918.00
1/10	1350 (S)	982.00
1/12	920 (S)	984.00
1/7	900 (S)	1171.00
1/5	1350 (D)	1172.00
1/8	1350 (S)	1000.00
1/4	930 (S)	1237.00
1/5	1459 (D)	1203.00
1/12	940 (S)	944.00
1/8	1350 (S)	968.00
1/4	930 (S)	1249.00
1/5	1450 (S)	1118.00

1/5	1350 (D)	1139.00
1/18	925 (D)	986.00
1/12	920 (S)	945.00
1/6	1410 (D)	1184.00
1/10	930 (D)	1007.00
1/6	920 (T)	1209.00
1/10	920 (S)	706.00
1/5	930 (D)	886 00
1/12	940 (D)	1012.00
1/15	920 (T)	920.00
1/20	920 (T)	902.00
1/13	875 (D)	979 00
1/8	920 (S)	1040 00
1/4	930 (S)	1261.00
1/83	1360 (S)	380 00
—	—	440 00
1/30	1275 (S)	448.00
1/83	1350 (S)	392.00
1/250	1400 (S)	440.00
1/35	1280 (S)	453.00
1/83	1060 (S)	385 00
1/15	1275 (S)	494.00

S D T stands for Single, Double and Three speeds respectively.

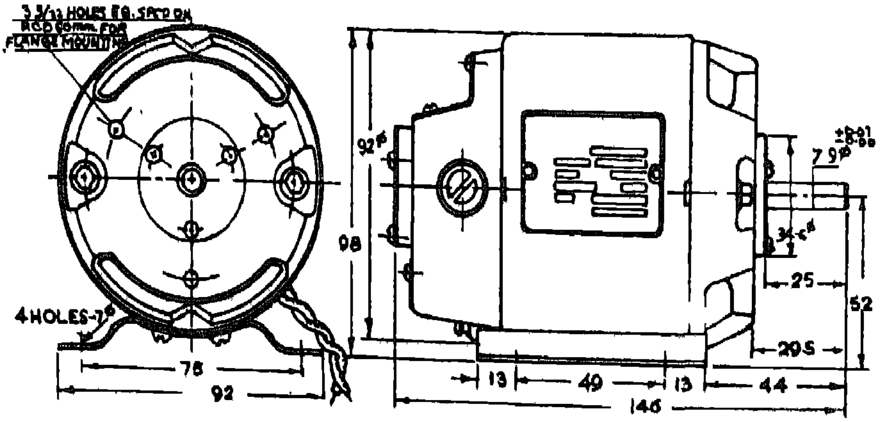


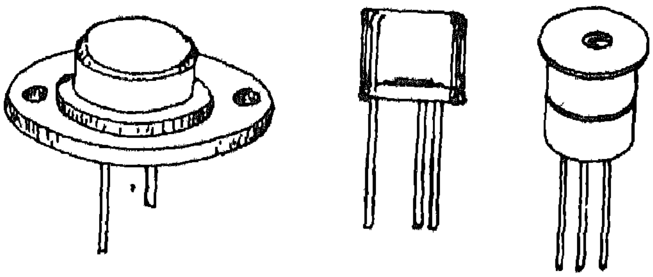
Fig 111 AC FHP Motor

(b) *Transistor:* Scientific interest in semi-conductors led to the development of the transistor. Transistors are classified according to:

- direction of current flow through the transistor i.e. NPN or PNP
- material (germanium/silicon)
- process by which they are constructed (grown-junction, alloy junction etc.)
- ability to dissipate power i.e. 50 mW (low power) to 2 Watts and higher (high power).

For identifying C (Collector), B (Base) and E (Emitter) of a transistor, several conventions are used depending on the design and construction of the transistor.

- Collector is identified by a coloured dot.
- tab (projection from the case) is near the emitter.
- case itself is the collector.



Transistor shapes

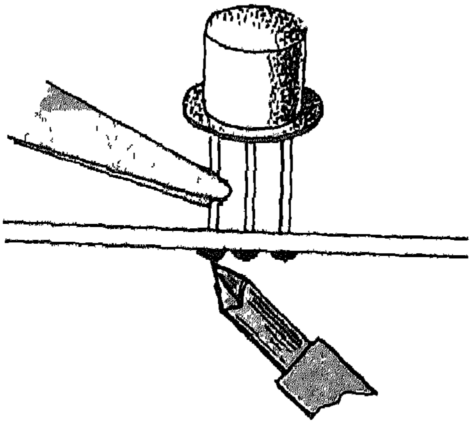


Fig 112. Soldering of transistors

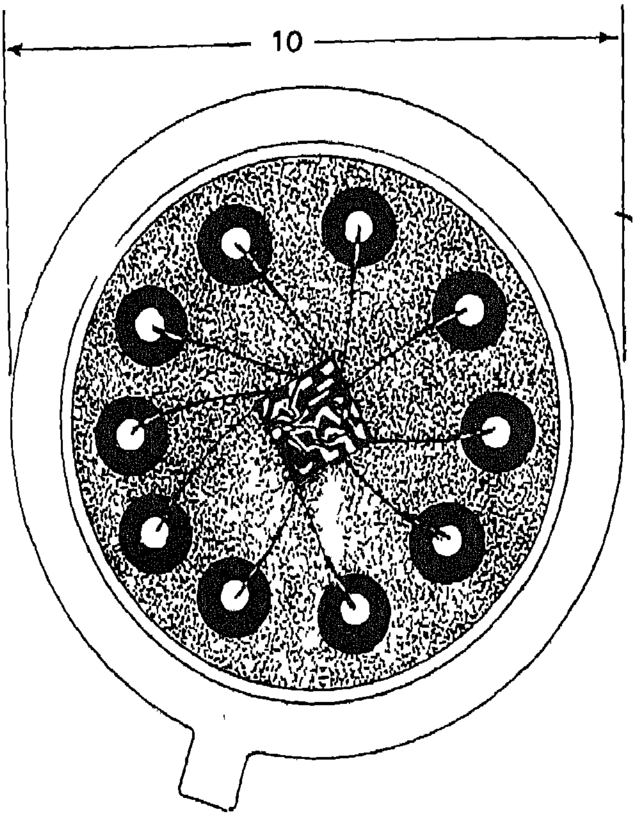


Fig 113. Digital IC (Ref 6)

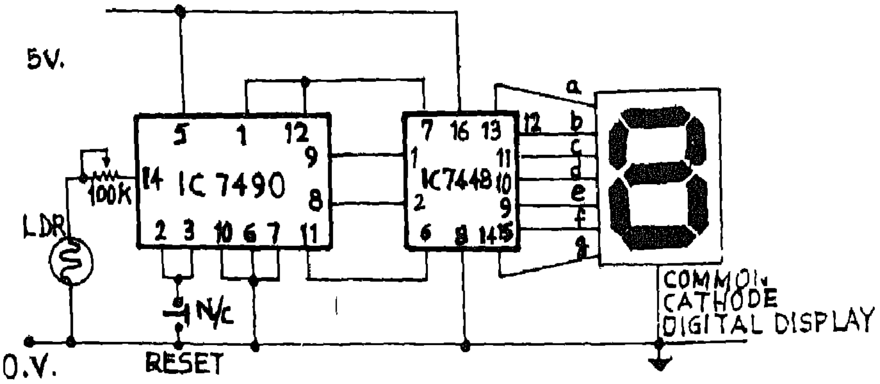


Fig 114

(c) IC (Integrated Circuit) also called a 'chip' has active (transistors and diodes) and passive (resistors and capacitors) elements. They are wired together by microphotolithographic process on a silicon chip which can be as small as a pin head. Fig.113 shows a digital IC 10 mm dia (magnified × 8) having 10 pins, mounted on a metal header.

A circuit using IC is shown in Fig. 114; this is the circuit for counting number (upto the limit of 10) of persons cutting light falling on LDR (i e. passing through a particular predesigned passage).

- Collect all types of diodes available and try simple circuits
- Do simple circuits with transistors
- Choose simple but utilitarian circuits from books, magazines on electronics projects (e.g. Electronics for You, Elector etc.)
- Use circuit board/breadboard (Fig. 107)

Combination of mechanical, electrical, electronics and other technologies is required in *robotics* This is one single (and also most favourite) field where you will find scope for application of your knowledge and skill in science and technology. Keep on collecting information about small modules e.g. design of legs—their movement and control, design of fingers and their movement for grasping objects, etc Also try the circuits of DC/AC fan regulator, electric gadgets, signal injectors, excessive temperature detector, etc. as given in the book mentioned at Ref 12 at the end of the chapter.

T

Electrical and Electronics Tools and Equipment (for a batch of 5-10 students working at a time)

(a) List

1. Soldering iron, 25 W	2
2. Tweezers, pointed curved ends	2
3 Neon Tester	2
4. Electrician's pliers	2
5 Wire stripper	2
6. Cable knife	5

7. Solderless Breadboard with socket spacing for any dual-in-line package IC	10
8. Stripboard cutter	5
9. Variable resistor from 6 to 2650 ohms	2
10 Capacitance Box, 220 pF to 1µF,220V	2
11 Multimeter DC-100 mV-3KV, 2 Kohm/volt, 50M-10A AC 3 V-3 KV,2 Kohm/volt, 10 MA-10A	1
12. AC volt meter 300 V	1
13 Signal Generator(freq. range 100 KHZ to 100 MHZ).	1
14 Oscilloscope (10 MHZ/ 10MV)	1
15. Power Supply (sensitivity 5 mV/Div)	
16. Autotransformer (power 200 VA)	11
17. Solar Cell power 0.3W, 57 mm dia, open voltage 0.45 V, load current 670 mA	30
18 Car battery	1
19. Coil winding machine	1

Others

Resistors, capacitors, diodes, relays, coils, magnets, LED's, IC's, wires, crocodile clips, banana plugs, cells, insulated copper connecting wire etc.

(b) Description of some common measuring instruments for electrical and electronic projects

(i) Soldering Iron

Soldered joints are required in most electrical and electronic circuits The Soldering Iron has a long thin tip of copper or brass—230 Volt, 25 Watt. Soldering Iron will serve the purpose for average range of work.

The heated tip melts soft solder which is an alloy of tin and lead. The molten solder is applied to the parts to be joined The solder has a lower melting point than the metals to be joined so that it can flow into the hot joint.

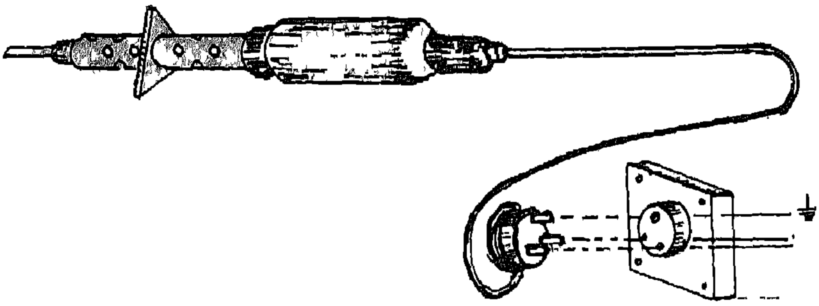


FIG 115. Soldering iron

Soldering gun is an improved version of a soldering iron. In the gun there is a primary winding to be connected to the supply through a switch. The secondary winding has only a few turns of heavy wire to send a large heating current through the tip. The voltage at the tip is less than 1/10 volt so that there is no danger of shock.

Surface to be joined by soldering are to be free from grease etc. otherwise solder will not stick. Flux or soldering paste is applied to the mating parts before joining. An active flux like Sal-ammoniac will remove grease, dirt and oxide. It should be washed off with warm water after finishing the joint, otherwise it will corrode the metal. Flux is available commercially in the name of soldering paste. Small soldering and iron has a narrow 'pencil' bit for working in confined spaces. Larger irons have hatchet shape or pointed bits.

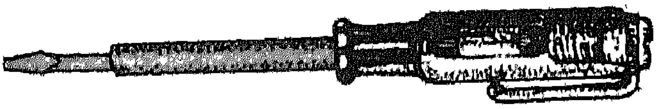


FIG 116. Neon tester

(ii) **Neon Tester or Mains tester:** This has a screw driver tip and a small neon bulb fixed in the plastic body. The presence of electricity in a circuit can be detected by the tester. The tip of the tester is made to contact the electrical point while the head of the tester is pressed by finger. The neon tester is very handy and can be carried in the pocket like a pen. A test lamp with thick leads is also used for the same purpose. (Fig. 116)

(iii) **Electrician's Screw Driver:** This is generally 75 to 250 mm long. Some screw drivers are further insulated by a plastic sleeve running down the length of the blade

(iv) **Electrician's Pliers or Line-man's Pliers.** The size is between 150 to 200 mm The material is steel, the handles are covered with insulating materials i.e. rubber, plastics. It is used to grip, pen and crop electrical cables. (Fig. 117)

(v) **Wire Strippers:** Recent wire strippers combine other functions to form a multi-purpose tool. The tip serves as screw driver. Lower part of the jaws form a wire cutter. The pivot pin is used as a wire looper. The opening of the jaws for stripping operation can be adjusted by an eccentric disc Below the pivot the jaws have typical profiles to perform crimping operation (Fig. 118)

(vi) **Breadboard:** The solder breadboard has rows of holes, each row is

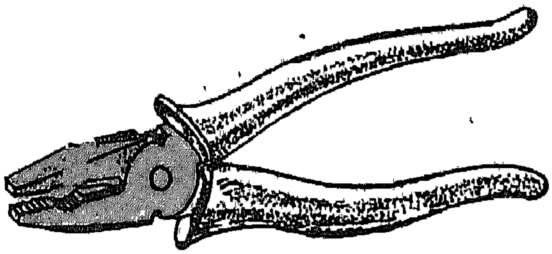


FIG 117. Electrician's pliers

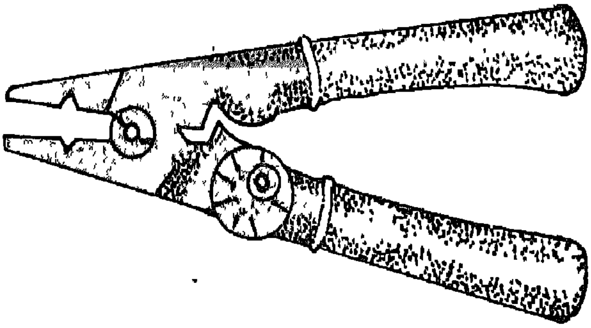


FIG 118 5-in-1 electricians tool (wire stripper, crimper etc)

connected by a layer of copper The standard size is 90mm x 65mm having punched holes of 0.8mm dia. This is for individual student projects and for practising soldering techniques of printed circuit boards (pcb).

A simplified circuit board is shown in Fig 107 You will be able to connect elements like resistors, capacitors, diodes etc on it and test the circuit quickly without soldering

Solderless breadboard (patch board) is also used for individual student projects This has also sockets for any dual-in-line package IC and any discrete device and passive component

(vii) **Power Supply:** For projects in electronics a power supply which will give DC at different voltages is required. This is also called Battery Eliminator. These are available in various ranges. One having steps of 1.5 volts and a range from 1 5 volts to 12 volts is very useful.

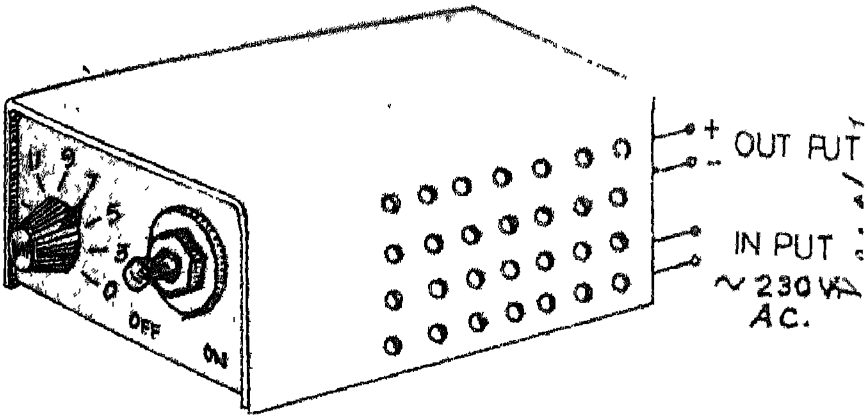


Fig. 119. Power Supply

(viii) **Ammeter:** An ammeter measures current. A moving coil ammeter of a range suitable for the project may be chosen. Ammeter is always connected in series with the element under measurement in the circuit. An ammeter must have a low resistance. The positive terminal of a DC meter is to be connected to the positive pole of a battery. A sensitive ammeter can be converted to read higher currents. For example, if one ammeter having a full scale deflection of 1 milliamperes is to be converted into one to read 1 amp, 999 milliamperes must pass through a shunt. If the meter coil has a resistance of 'R' ohms the value of the shunt can be worked out to be R/999 ohms.

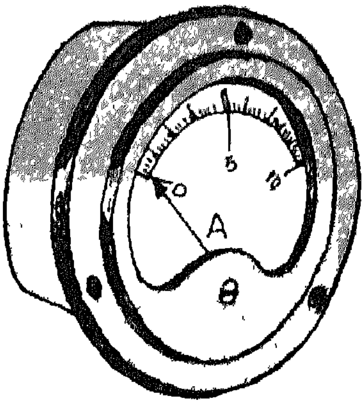


Fig. 120. Ammeter

(ix) **Voltmeter:** A voltmeter measures voltage. A moving coil type having a range suitable for the project may be chosen. The voltmeter is always connected across (in parallel) the part whose voltage is to be measured. A milliammeter can be converted into a voltmeter. This is done by connecting a ressistance of appropriate volts in series with ammeter.

(x) Ohm meter: A moving coil milliammeter or microammeter can be converted to read ohms This can be achieved by applying a cell of known voltage. A resistance scale is in the reverse-direction to the ampere and voltage scale. One of the most common uses of this meter is to check continuity in a circuit

(xi) Potentiometer: Potentiometer has three terminals In the wire wound type the track is made of coiled wire, whereas the preset type has a carbon track. Potentiometer has maximum resistance between two terminals which may increase linearly or logarithmically. The linear type is most common. Slide-wire potentiometer is another simple type of variable resistance. Here the wire (one metre long) is connected across the known and unknown 'to be measured' resistances, a 'balance point' on the wire is reached through trial and error when no current passes through the milli-ammeter (Fig. 121b). Knowing the resistance per unit length of the wire, value of unknown resistance can be calculated. In Fig 121 (a) & (b) R_K = Known resistance, R_U=Unknown resistance. As shown in the Fig 121(b).

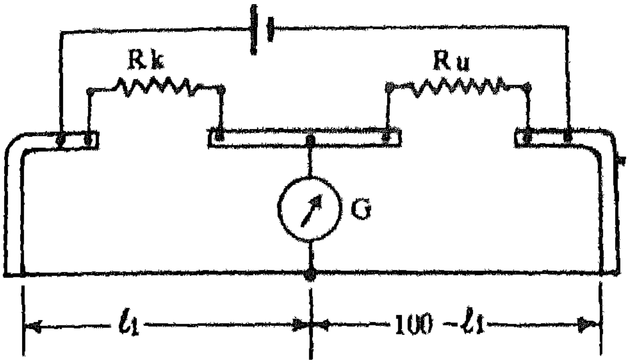
$$\frac{R_K}{R_U} = \frac{l_1}{100-l_1}$$

(xii) Multi-meter: This instrument is a must for the amateur as well as the professional. Measurement of amperes, volts, ohms can be done separately with the help of this instrument Hence it is also called AVO-meter.

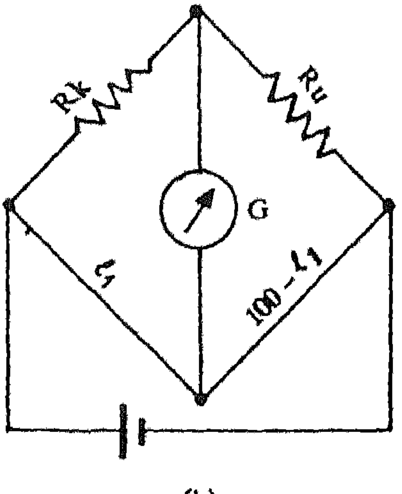
Multimeter has an internal battery. When the meter is switched on to measure ohms the battery gets connected. Suppose you are to measure 4.7 K ohms

- Switch on to ohm × 1k position
- connect the leads together so as to check whether the needle moves to zero position of the scale
- turn 'ohms adjust' or 'zero' of the meter to bring the pointer to the zero position.
- finally join the leads to the ends of the resistor and read off the value from the scale.

It responds to currents as low as a few millionths of an ampere Addition of series and shunt resistance to this basic ammeter makes it act as a multi-range ammeter and voltmeter It has also rectifier diodes in its internal circuits so as to measure both AC and DC quantities. Good quality multi-meters have 'cut out'



(a)



(b)

FIG. 121

consisting of an electro-magnetic switch which protects the meter from overload current due to misuse. The multi meter is available generally in two sizes; the smaller version is suitable for average work on electronic circuits. The bigger size has a wider range. An instruction manual accompanies each instrument which is to be strictly followed.

(xiii) **Digital multi-meter:** In this generation of multi-meter the values are no more read on the scale and pointer but they appear as display (as numbers in gas-filled numicator tubes or on solid-state light arrays) Digital instruments are

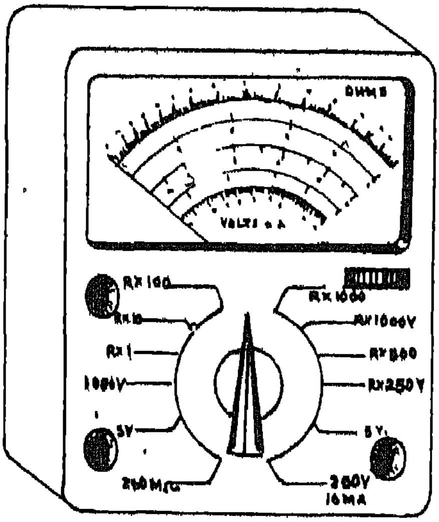


FIG. 122. Multimeter or AVO meter

quicker to use.

(xiv) **Oscilloscope:** Wave forms cannot be studied with conventional type of indicating instruments. CRO (Cathode. Ray Oscilloscope) is used for seeing and measuring voltage changes, time, frequency etc. The Oscilloscope may be considered a type of indicating meter which is almost inertialess in following rapid impulse changes. To start with, an ameter can observe and measure voltage changes, time and frequency on the oscilloscope. The main part of this instrument is a cathode ray tube. The electron beam traces a path on the screen in accordance with successive instantaneous values of applied voltage. So CRO enables us to investigate complex wave forms which would otherwise be impossible to view. (Fig. 123)

Don't make any attempt to open the internal circuits as they may carry lethally high voltage. Read the instruction manual carefully before switching on the instrument.

(xv) **Signal Generator:** A typical signal generator or oscillator can produce waves in the audio-frequency, radio frequency, very high-frequency or ultra high frequency range. This instrument provides a continuously varying voltage across the out put terminals. The output on the signal generator can also be changed from sinusoidal to squarewave. Instructions in the operation manual accompanying the signal generator are to be strictly followed.

Electromagnetic Spectrum: Electrical signals may have any frequency starting from zero (direct current) to above billion billion billion Hertz (cosmic rays)

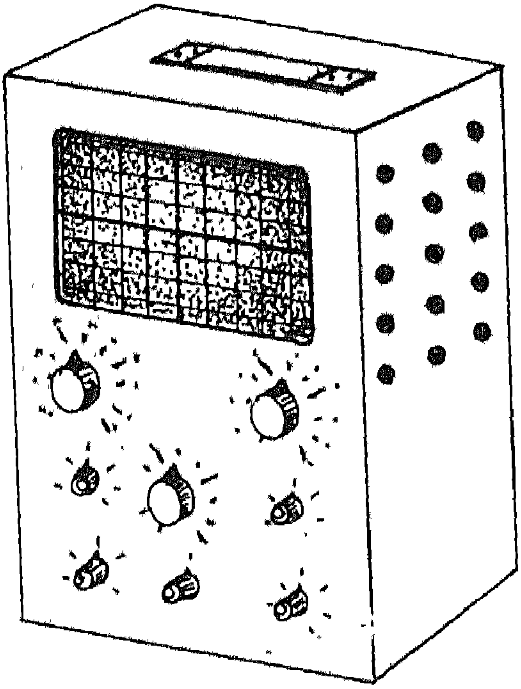


FIG. 123. Oscilloscope

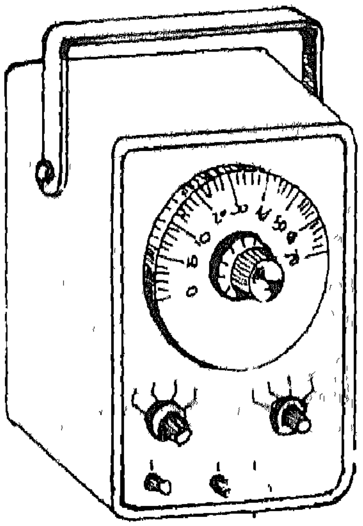
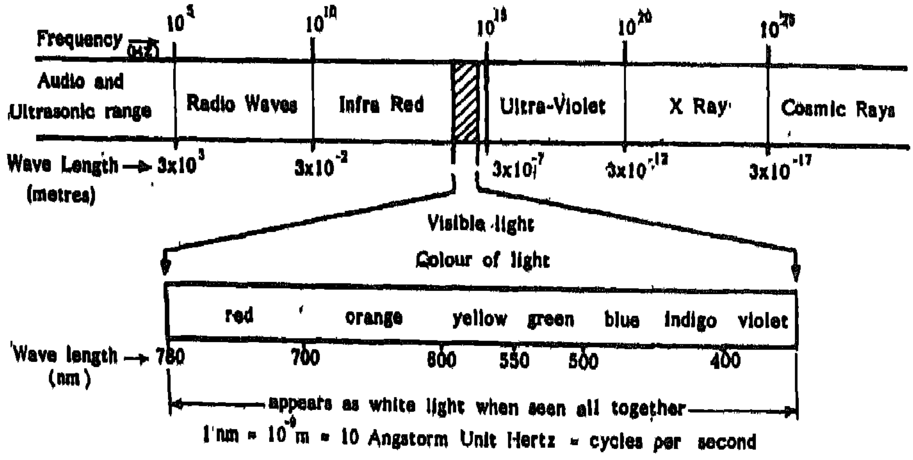


FIG 124. Signal generator

Electrical energy with frequencies below 100,000HZ (100 KHZ) cannot easily travel through space as radiated waves, it needs electrical conductors to travel. Sound waves—auidible to human ear, when converted into electrical signal, range in frequencies from 20HZ-20KHZ. This is called the *audio frequency range*. Frequencies ranging from around 20KHZ to around 60KHZ can be grouped under the Ultra-Sonic Wave category. Electrical energy above frequencies of around 100 KHZ can travel through space as electromagnetic radiations and are commonly classified under the *electromagnetic spectrum*. Strictly speaking, electrical energy with any frequency above zero can be classified as electromagnetic waves. The chart below shows the Spectrum of Electromagnetic Waves.

Classification of Audio & Radio Frequency Spectrum: A more detailed classification of the audio and radio frequency spectrum is shown in Table 3.



Electromagnetic spectrum and visible light

7.4 Electronic Display Devices

Simplest format of display comprises of a series of bulbs arranged in the form of letters, numbers or simple diagrams. These letters, numbers or diagrams can even be illuminated with the help of a pre-set control, the simplest form of which could be a small motor having rotatory contact with the segments in the circuit connecting arrays of the bulbs. The letters, numbers or diagrams can also be comprised out of neon tubes. Nixie tubes which were popular for small size displays in electronic instruments, have now become almost obsolete.

Light Emitting Diodes (LED) are ideal for small displays as often required for flashing reading or information alongwith the exhibit. These are ideally suitable for displays which are kept in the dark and required to generate their own

TABLE 3. Classification of Audio & Radio Frequencies

Frequency	*Wave length*	*Designation*	*Applications*
3HZ-30KHZ	10m^8-10^{4}m (m=metre)	VLF Very low frequency	Long range navigation and also undersea navigation, timing standards 20HZ-20KHZ-audio frequency (human beings can hear this range)
30KHZ-300KHZ	10m^4-10m^3	LF Low frequency	Navigational aids, radio beacons, communication through electric power line. 150-285 KHZ-AM broadcast radio long wave range.
300KHZ-3MHZ (1MHZ=Mega HZ=100KHZ)	10m^3-10m^2	MF Medium Frequency	Civil defence, amateur radio 540-1500KHZ-AM broadcast radio Medium Wave range
3MHZ-30MHZ	10m^2-10m	HF High Frequency	Amateur radio, mobile radio communication, military use 6MHZ-26MHZ-All broadcast radio short wave range.
30MHZ-300MHZ	10m-1m	VHF Very high frequency	Air traffic control, police radio, navigational aids 47-68MHZ-VHF TV Band I (ch2-4) 88-108MHZ-FM Radio 174-230MHZ-VHF TV Band III (ch5-12)
300MHZ-3GHZ	100cm-10cm	UHF Ultra High Frequency	Radar, Space communication 470-860 MHZ-UHF TV Band IV Vich 21-69)
3 GHZ-30GHZ	100 cm-1cm	SHF Supar High Frequency	Radar, Satellite, space communication microwave communication.
30GHZ-300GHZ (300 GHZ=3×10^{10}RZ)	10 cm-1mm	EHF Extremely High Frequency	Radio astronomy, experimental uses.

illumination. The field of view in LEDs is low. The current consumption of a segment with LEDs is around 10mA. A typical seven segment display may however need an average of 50mA.

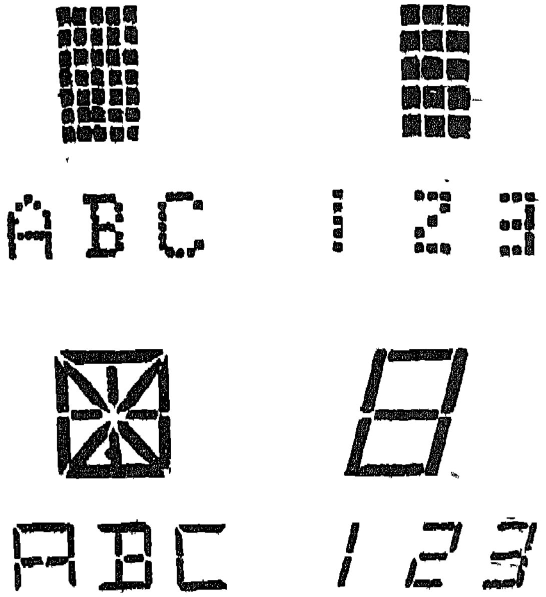


FIG 125. Typical display segment formats

Liquid Crystal Display (LED) has a very wide field, but it cannot be seen in the dark The current consumption of a segment is 5 nano amperes. These are ideally suitable for operation with small cells.

Research and development in the field of display technology are very fast and this is one of the fastest developing fields today. This is due to the demand of electronic information display in the various industries and consumer product market. Old display techniques are steadily dying out and are being replaced by newer ones to satisfy the needs. Electronics displays are often called *interface devices* Display such as TV screens and Cathode Ray Tubes(CRT) are sometimes called output devices. Light pen, touch pad, key board etc., can facilitate the feeding of information to machines in a direct or indirect manner. Display techniques today may be classified into the following categories.

Active Display	*Passive Display*
(Light Emitting Devices)	(Light Modulating Device
CRT-Cathode Ray Tube	LCD-Liquid Crystal Display
PDP-Plasma Display Panel	ECD-Electrochromic Display
LED-Light Emitting Diode	EPD-Electrophoretic Display
ELD-Electroluminescent Display.	

CRT may be further classified into:

1. Direct-view Refresh CRT,
2. Direct-view Storage CRT
3. Projection CRT-screen size 2.3 to 3.3 metres.
4 Special CRT-high resolution
5. Flat Panel- fluorescent character panel e.g. 6 lines of 40 characters.

CRT is the dominating display technology for medium and larger displays. In low medium display domain(20-500 characters), PDP,LCD, etc are completing with rapidly advancing CRT. There is no technology to replace CRT for displaying 5000 characters and above. LCDs are gaining their market more rapidly than the other technologies. ECDs and EPD(s) are yet to enter the market. Fig. 125 shows display segment formats in alphabetic (5×7 arrays) and numeric (3×5 arrays) displays.

For alphabetic and numeric output 14 bar and 7 bar displays are respectively required. This is offered by light emitting diode (LED), gas discharge and liquid crystal displays, vacuum flourescent, electroluminescent and incandescent filaments. Beyond 200 characters, technologies are scare and the demands are met by CRT.

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IV

Display Techniques

Learning Objectives

After carefully going through the text and examples which are new to most of you, you will be able to

- *identify essential graphics material*
- *prepare graphics.*
- *generate graphics on a computer (with initial introduction to the system)*
- *visualise balanced composition on display boards.*
- *make a suitable display board for your school under the guidance of your teacher.*

1. What is Display ?

Display is one of 'mass media' which is generally used to educate, advertise products and stir our thoughts. It has also persuasive force in captions like 'one good act a day', 'there is no substitute for hard work,' 'god helps those who help themselves',etc.. When we are in public places like railway station, bus terminal or stadium, our eyes are attracted by various pictures and words displayed around the place. The sign-boards compete among themselves, those using movement with illumination gain upperhand. The space occupied by commercial advertisements in newspapers and magzines is increasing steadily. On the footpath, in the market place and even in the train compartment we see displays and demonstrations where again choicest words,alluring tunes and eye catching skills are found. We cannot escape the commerical advertisement even in our homes. Radio and TV are increasingly becoming generous in showering words and visuals of commercial advertisements. Researchers, psychologists and artists are constantly working together to create displays which can have greatest emotional and intellectual impact. In this chapter displays for educational purposes particularly those required for your presentation of exhibits in the science exhibition will be discussed.

2. What are Graphics ?

Graphics imply materials which illustrate ideas, objectives, concepts and processes clearly through synthesis of drawings, pictures and words. They provide direct, purposeful, multi-sensory experiences and produce dynamic and holistic field of stimulus in the mind of the viewer. 85 to 95 per cent of signals or sense-stimuli enter our perception through the eye and ear. Audio-visual materials help us learn about 35 per cent quicker and retain 55 per cent longer Other advantage of such materials may be consolidated as follows

— increase participation
— try to make learning permanent
— reduce verbalism
— develop better understanding
— stimulate interaction
— overcome language barriers
— disseminate the message to more number of people.

There are two distinct varieties of graphics—projected and non-projected materials. Film, filmstrip,slide and transparencies are projected ones. Non-projected materials are diagrams, graphics, charts, posters, cartoons, illustrations, comics, pictures, photographs, maps, etc.

Have you tried to verify the fact in the saying "a picture is worth 10,000 words?"If not, try now

Classification of Graphics

Diagram

As shown in Fig 126 a diagram is basically a simplified drawing formed by lines, geometrical form and symbols with minimum details. Visual summaries of facts are condensed in diagrams.

Graphs

A graph shows quantitative relationship at a glance. It shows mainly comparison and relationship of masses of statistical data mainly. There are different types of graphs like bar graph, line graph, pie graph etc

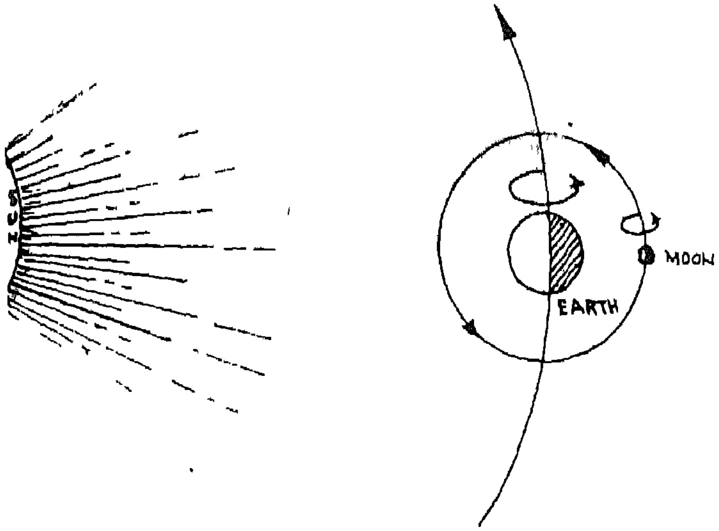
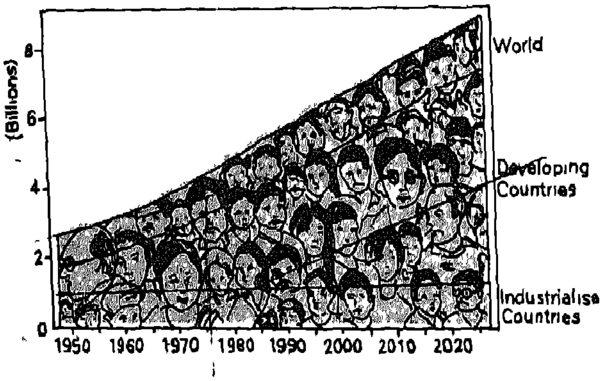


Fig 126. Motions of earth and moon. (Distance earth-moon 3.844 lakh km nearly)
earth-sun 15 crore km nearly)



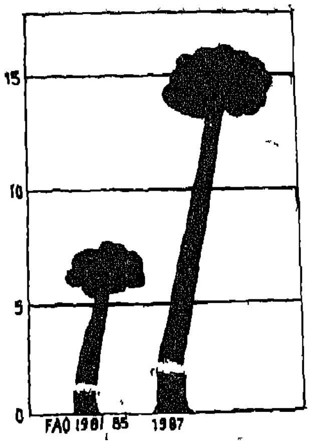


Fig 127. Increase in global population

Fig. 128. Inreare in deforestation

Charts

A chart is useful to visualise relationship between key facts and ideas in a simple, methodical and logical manner There are flowcharts, tree charts, tabular charts etc which are used for different purposes

Posters

A poster is symbolic and bold as it carries just one fact or idea. It is basically used to motivate, remind advertise and arouse interest. Because of its dramatic presentation, it holds the eye

Cartoons

A cartoon is a metaphorical representation in the form of a sketch. It adds intelligent humour to the implied message. It can also dramatise satire, caricature or exaggerate ideas, persons or situation. It can influence public opinion with its sharp compact drawing conveying a single idea.

Comics

A comic strip depicts story in sequence which is meant to entertain people It is also a form of cartooning; it brings movement additionally.

Picture

Pictures can arouse interest, stimulate discussion, raise question and supply information and ideas. Flat pictures are easily collected from books, newspapers, periodicals and magazines at no cost. These can be of many uses to create real environment. Due to the limitation of two dimensions, it cannot give accurate perception of depth The other disadvantage is that it cannot provide movement. Of course, no medium of visual communication is more familiar or more widely used than the picture.

3 *Three Dimensional Materials*

Models, specimens, objects and dioramas are very powerful and effective. These are scale models, near-real, true replica, enlarged or miniaturised or sometimes simulated form of the original. It can also provide interior view of the object with the help of longitudinal or cross sections. In a model one can get a feel of the curvature, surface, dimensional proportions, texture, colour etc of the original. In Chapter III you have learnt how to prepare simple models.

Diorama is also a 3-D material which provides three or four surfaces i.e. foreground, middle ground and background to create a 3-D effect.

4 *Equipment and Materials for Making Graphics*

Common equipment and materials are a small table, drawing board, T-square, set squares, protractors, french curves, templates, drawing pins, pencils, eraser, poster boards of various colours, cardboards, tracing papers, poster colours, black Indian ink, colour

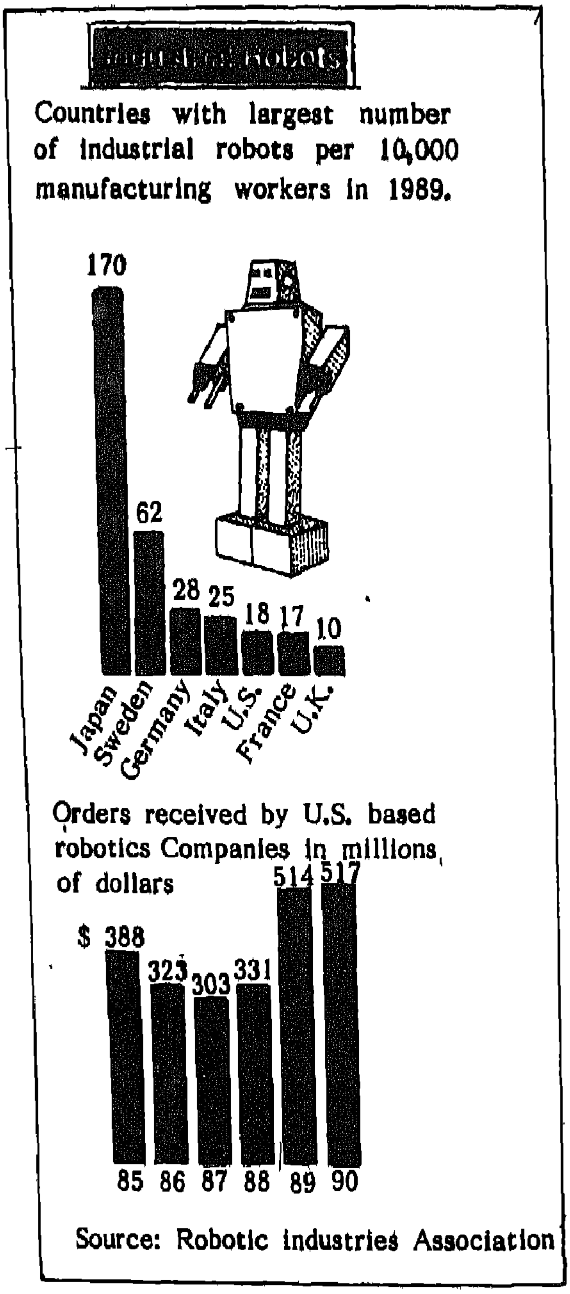


FIG. 129 Bar graph

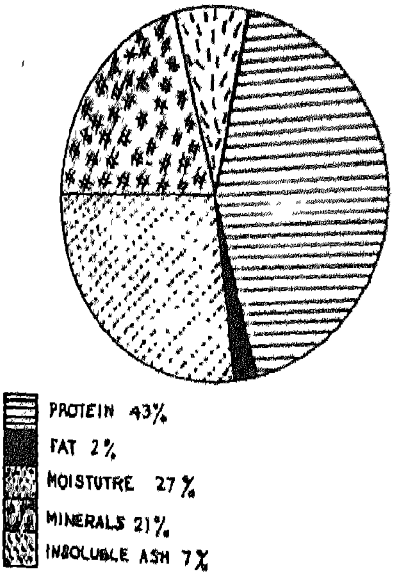


FIG. 130. Food value of sea cucumber (pie graph)

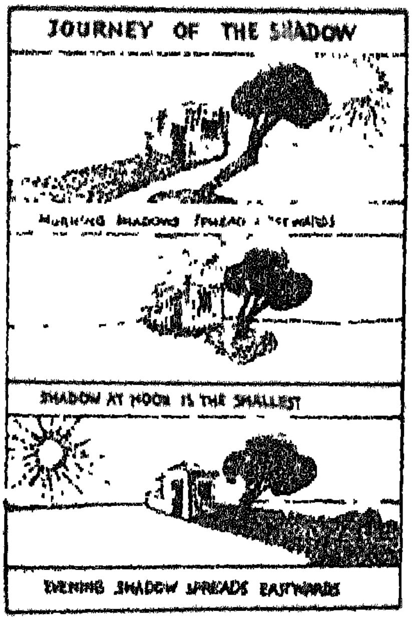

JOURNEY OF THE SHADOW
MORNING SHADOWS SPREAD WESTWARDS
SHADOW AT NOON IS THE SMALLEST
EVENING SHADOW SPREADS EASTWARDS

FIG. 131 Chart

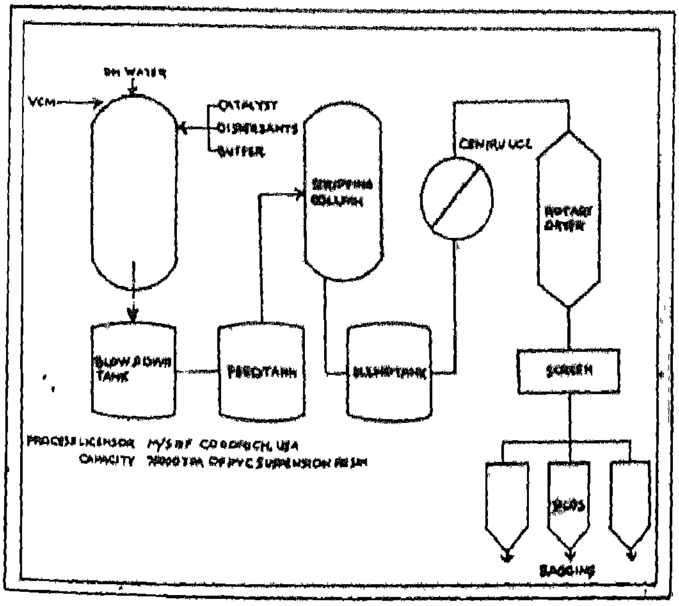


FIG. 132. Chart for Polymer Processing

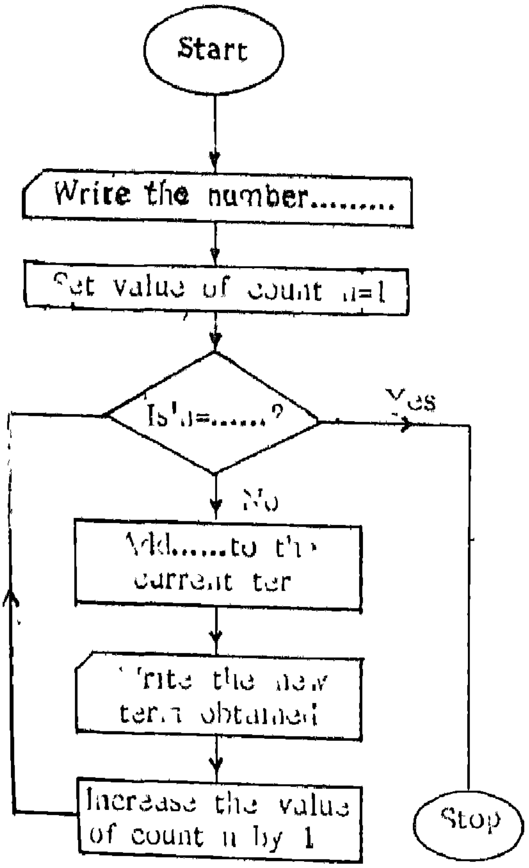

Start
Write the number.........
Set value of count n=1
Is n=......?
Yes
No
Add......to the current term
Write the new term obtained
Increase the value of count n by 1
Stop

FIG. 133. Flow Chart for Computation

Fill up blanks in Fig. 133, considering that 10 terms, the first of which is 153, are to be computed by adding 30 at each step.

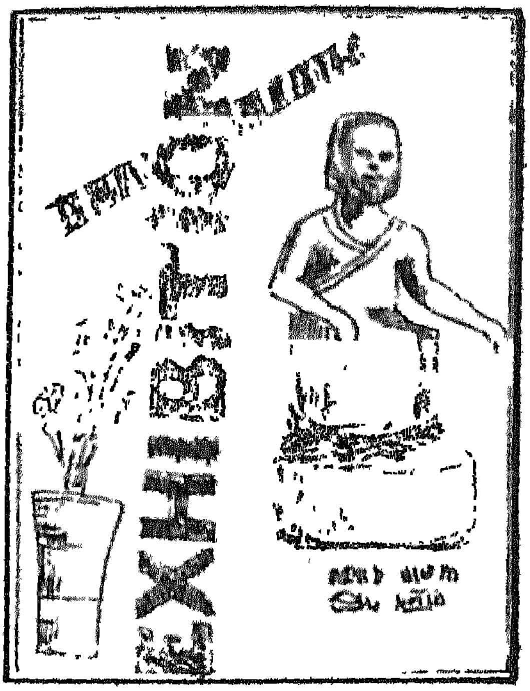


FIG. 134. Poster (Ref. 3)

mixing plates, crowquill pen, adhesive, lettering set, letters, camel hair brushes, blades, knives, drawing instrument box, pen set with 0.1 to 0.5 hollow nibs, colours, markers, feltpens of different types. These are available in shops dealing in art materials. A beginner should learn the right use of each. Details of some of them are given below

Paper— heavy paper, plastic coated paper, wrapping paper are generally used. Backing-poster board, Bristol board, tag board etc are good backing materials.

Adhesives— Rubber solution, quickfix, fevicol, paper tape, cloth tape, paper gum, cellotape etc are very popular. Also refer to section 4 of Chapter III. *Tapes and symbols*—Colour tapes of different width are available. Those can be used to make bar graphs and to put bold lines for giving importance to the topic. Different symbols are also available for ready use.

Brushes—are available in great variety of size, shape and type. Lettering with

FIG. 135. Cartoon

the help of the brush require enough practice, patience and experience. A flat-edged lettering brush is used for general lettering work. Fitches having chiselled edge are very good for sign lettering. Stencil and stipple brushes have short and stiff bristles. Paint is applied with repeated downard strokes while using stencil brushes and in this case do not brush from left to right. The brush should be invariably thoroughly cleaned every time after use. After using water colour the brush should be washed in lukewarm water and soap. In case of oil based paint the brush is to be washed in turpentine or benzene and then in soap and water.

Paint—A professional training is required for complete mastery of paint for art work. The opaque water colour paints or poster colours are to be used by an amateur to start with (also see section 3 of Chapter III).

Drawing Ink and Pen—black thick ink is used for writing on thick drawing sheets and tracing papers. These are used now-a-days generally in pens having tubular nibs of various diameters. The size of the nib is from 0.1 to 0.8 in steps of 0.1. Nib 0.3 produces a line of average thickness. The crowquill pen is cheaper and popular with only those who have mastered its use.

Grease Pencils—These are used on surfaces like glass, plastic, photographs which are glossy. Out of various available colours, dark blue, red, yellow or white are

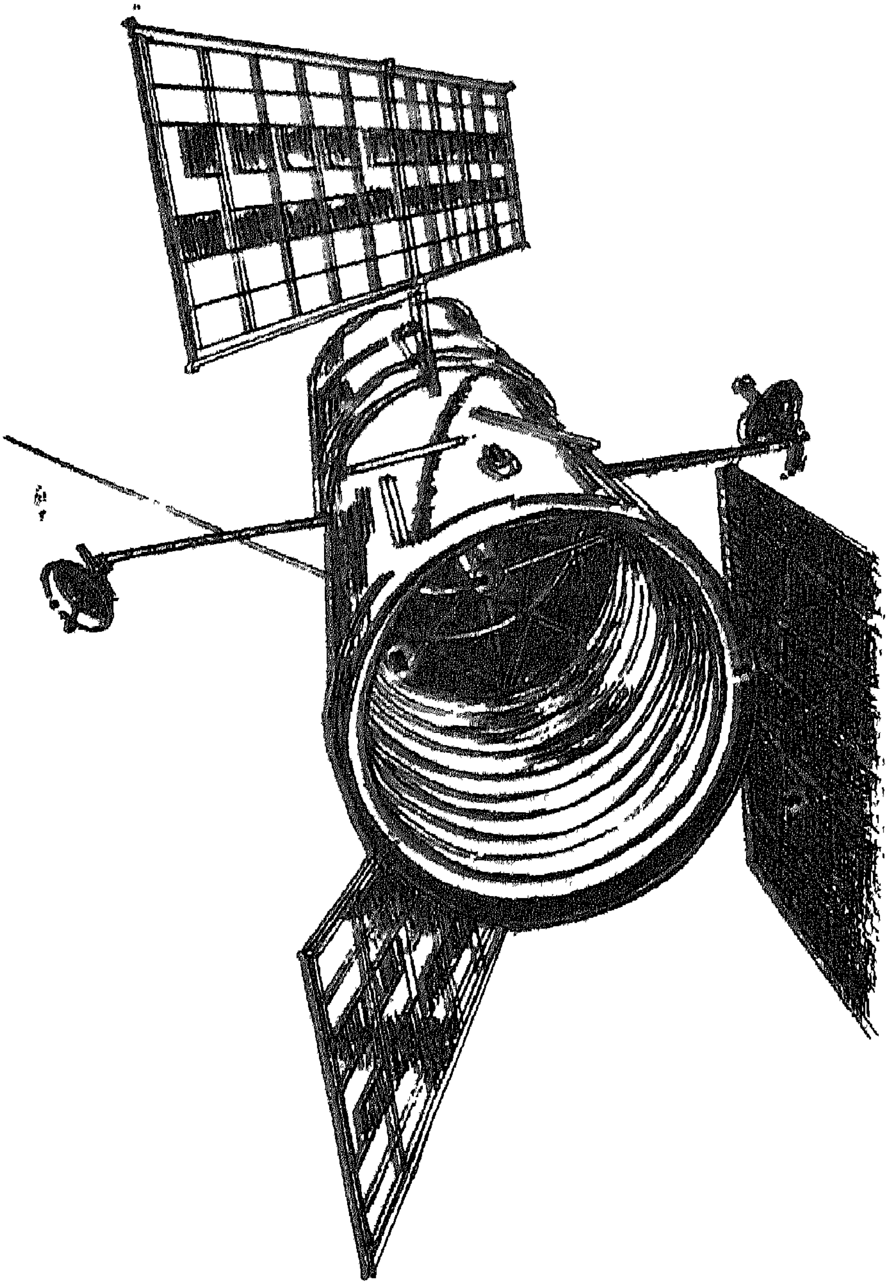


Fig 13.6 Illustration of Hubble Space Telescope

FIG. 137. Comics

FIG. 138

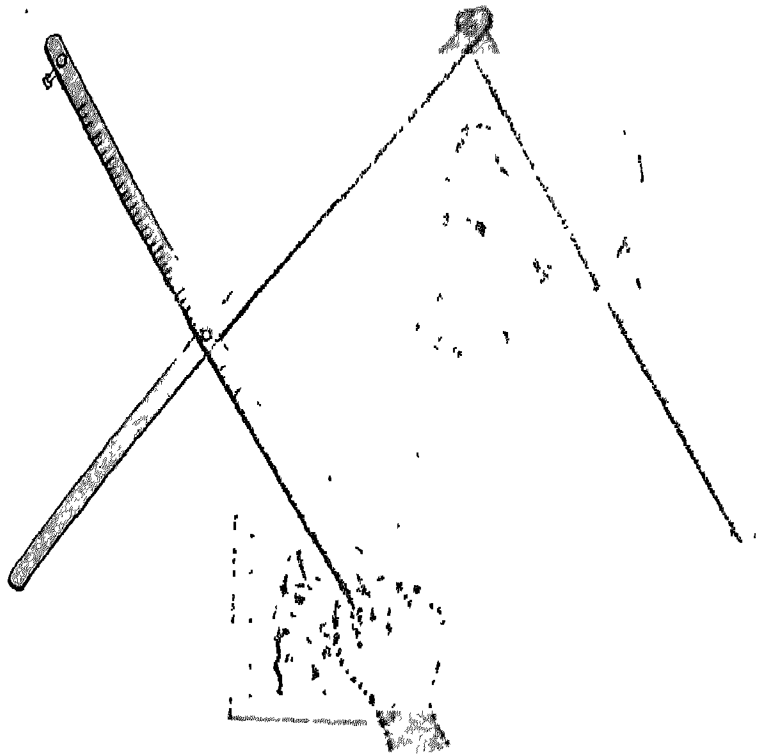


Fig. 139 Pantograph

used for contrast marking on dark surfaces. Colours like cream, black, purple are used on light surfaces.

Dyes for tinting — tinting photographs and other graphics brings dramatic [illegible]. This is done by dampening both sides of photographs or pictures with well dampened cotton. Soluble transparent dye diluted with water is then applied with the help of a wad of cotton. Make linear strokes with the wad in the same direction until the required colour form is obtained. One has to be quick enough not to leave streaks.

Pantograph — As shown in the Fig. 139, it can enlarge and reduce drawings. The original is followed with a tracer point, a duplicate is produced in the desired larger or smaller size by a pencil fixed at the meeting point of two arms of the pantograph.

Transparent films —Clear transparent acetate sheets are useful as protective covers for art work, display materials etc. One variety of acetate films can be painted with water colours, inks or dies without the paint spreading. Acetate and gelatine sheets are available in various colours. Their transparency can convert black and white art work into coloured ones. This can also be mounted on display boards for highlighting etc. Tinted sheets of transparent cellophane as used for gift wrapping

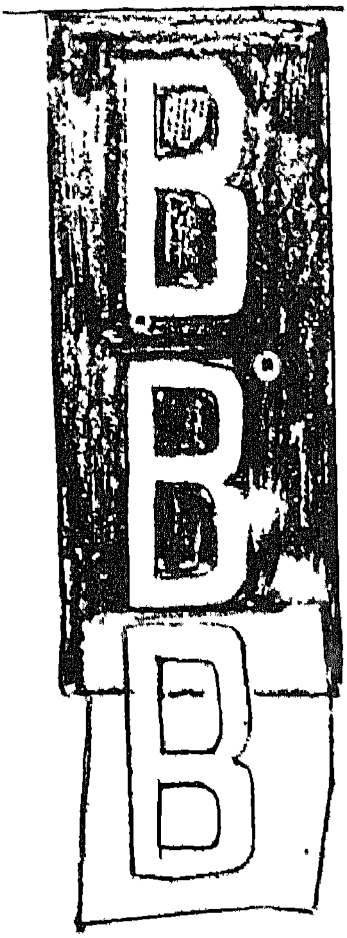


FIG. 140. Vinyl letter

are excellent materials for coloured lighting.

Over lay sheets—These have colours, patterns, dots, lines, various textures shading etc On rubbing the overlay sheet on paper or panel, the pattern can be transferred to the desired area in the same way as dry transfer letters are used Out of these patterns dots are mostly used with different densities.

Lettering and Typography—The viewer likes to get the message easily without any strain. Lettering size generally varies from 48 pt. bold to 18 pt depending on layout and distance from the viewer. Inside an exhibition pavilion or hall, letters should be readable by normal eyes atleast from a distance of 3 metres. A good idea or caption is generally lost if the lettering is offending to the eyes. One of the following methods may be adopted by the beginner depending on the resources available

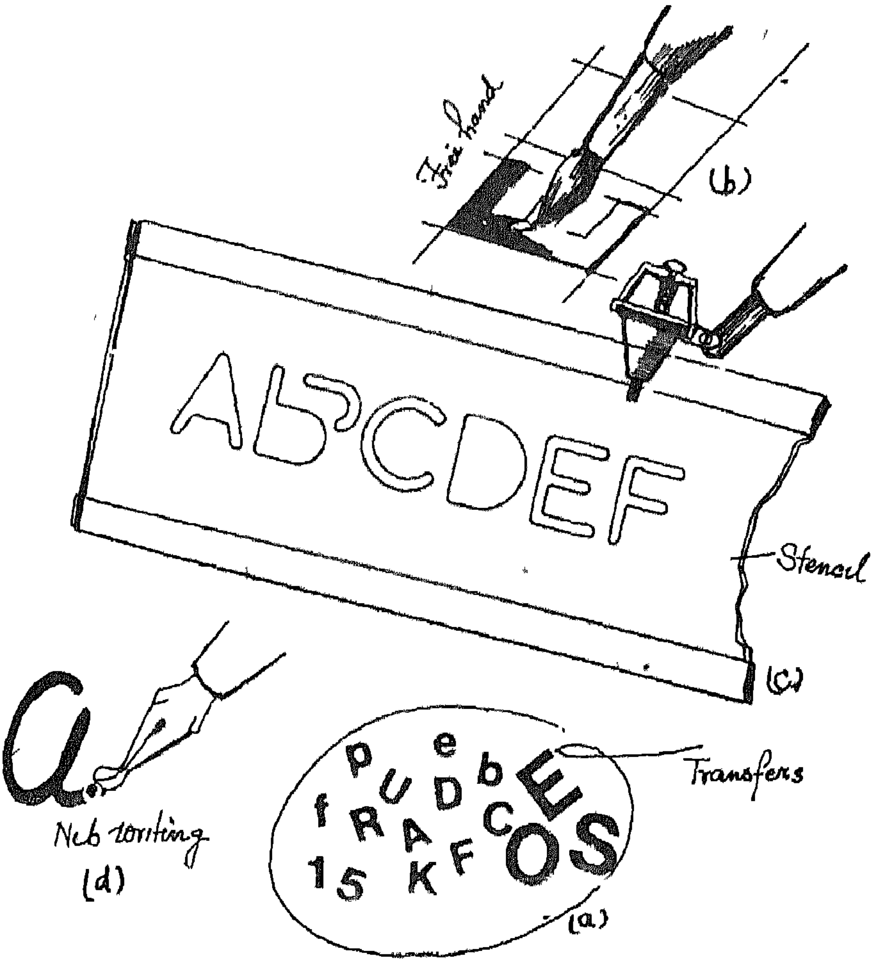


FIG. 141.
(a) dry transfer alphabets, (b) template and brush.
(c) stencil and pen (d) broad point pen.

In typewriter typography, typing on ordinary or preferrably the electronic typewriter with double space will give a very elegant get up. The typed copy can be converted to white-on-black by photographic process.

All possible styles of lettering are available on the computer. The printers can print innumerable types of lettering in various sizes. Various types of graphics are also offered by computers which can go very well with almost any layout.

The reduction and enlargement on the photostat machine offer very quick reproduction. The print can also be taken on glossy or matt surface or even on transparencies. The text for a poster can be typed on the typewriter and then blown upto poster size Upper case capital letter in an average typewriter is nearly 3mm wide. A readable poster text composed of 12mm wide characters can be obtained by enlargement. Though 12 mm wide characters could be adequate for a display but the letter itself will be fuzzier. For this, initial typing should be with a new ribbon on a very smooth paper.

Plastic letters — Various colours and sizes of plastic letters are very popular these days and are available everywhere. They are generally glued to a plastic base which is mounted on the display board with screws. The plastic letters are also available with small magnets on the inner face so that they can be easily aligned and displayed on mild steel sheet surface.

Vinyl letters—These are available in complete alphabets i.e. upper and lower case mounted on a backing sheet. The letters have to be peeled off the backing sheet with knife. The pressure sensitive adhesive on the back of each letter fixes the letter on the desired place once it is pressed down firmly. This plastic letters don't tear or deteriorate easily. 25 mm, 22 mm and 8 mm sizes are common, they are available in a variety of colours.

Dry transfer alphabets—These are available in specially coated sheets and those can be transferred on a surface simply by rubbing them. Letters are rubbed down from the alphabet sheet one by one to the pre-designed areas; they will adhere to any smooth surface.

Embossed letter—Printed raised letters of self adhesive plastic tapes can be produced on a letter embossing machine. You have to turn the alphabet dial to the desired letter, squeeze the handle and the letter is embossed. A wide variety of colours on the background tape and choice of width from 6 mm to 20 mm are available.

Alphabet templates and lettering guides—Though readable, they don't make quality letters. These templates are usually cut from clear plastic sheets (Fig. 141 C.)

Stencil alphabets are also cut on thin sheet metal or stiff paper called stencil paper. By tracing the outline one can laydown a perfect stencil letter. In another design the stencil pattern is filled with ink by ink-pen or stencil brush.

Markers—Felt-tip markers are ideal for free hand lettering. This may be applied on wood, plastic, fabric, paper etc. One of the disadvantages is that the ink is indelible. The problem of drying up can be sometimes solved by applying a few drops of warm water. The ink from the same manufacturer may be procured for

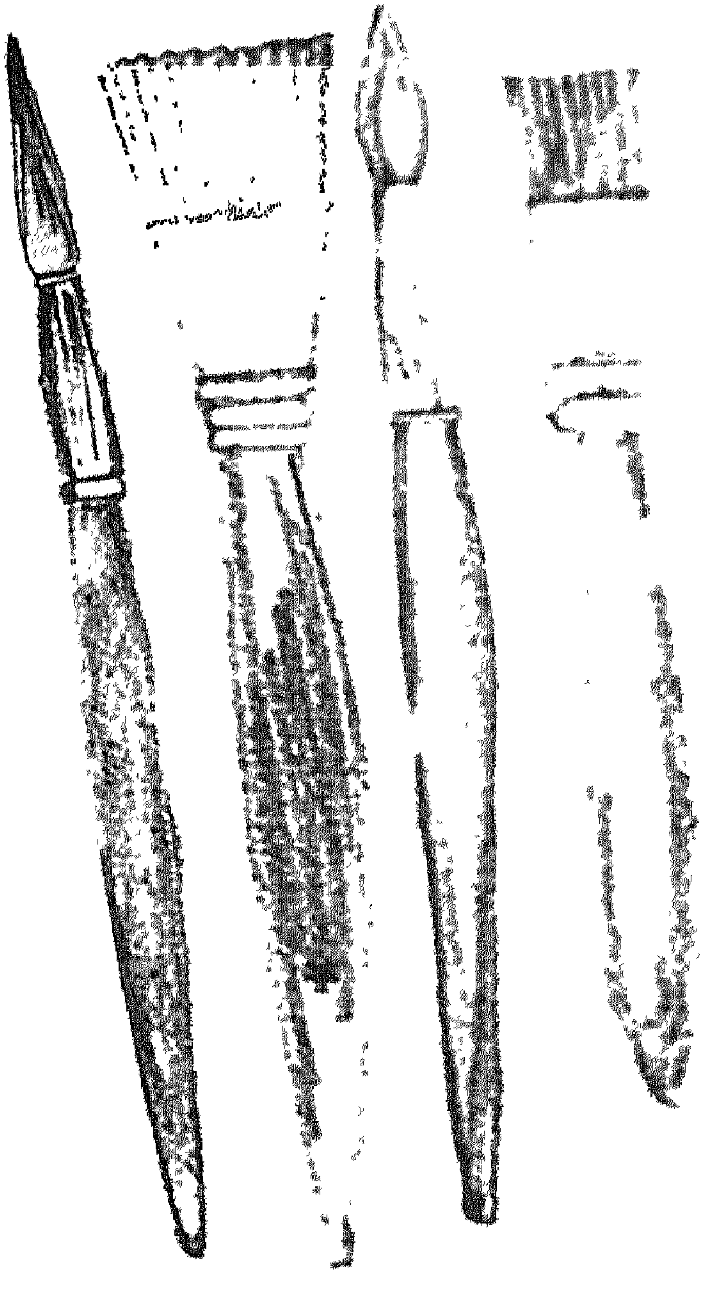


Fig. 142 Brushes

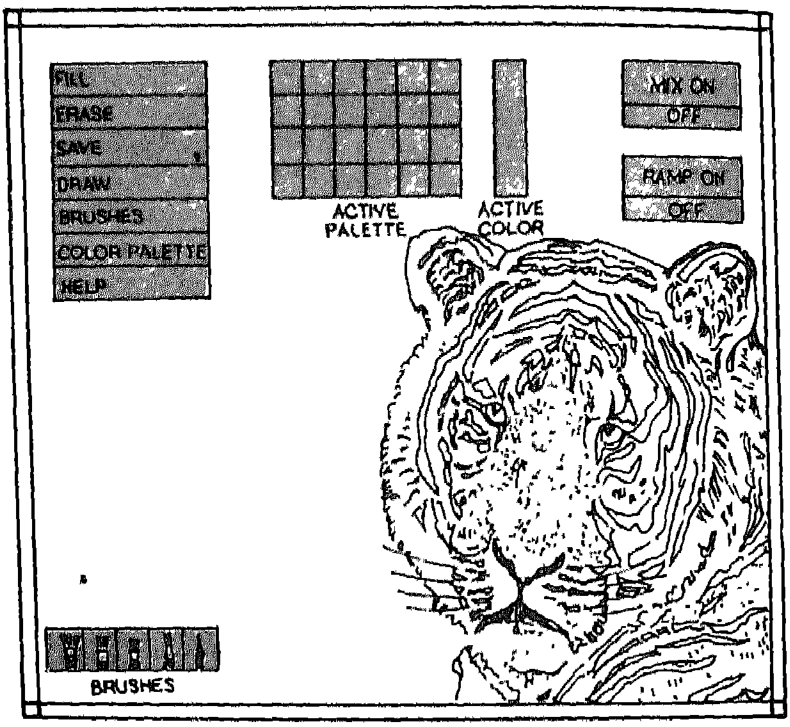


Fig. 143

giving the marker a long life The felt-tip is available in various sizes and shapes. A judicous combination of those can bring many variations in lettering.

Broad-point pens —These are generally used by calligraphers, experienced artists. Points of various thicknesses are available—each has its own style of letter thickness.

5. Simple Techniques for Drawing, Photocopying etc

Professionals know many simple techniques for drawing, copying etc. which cost practically nothing. Two examples are given here. You should find out more innovations to save time and labour.

(a) Indigenous photocopying· Make a mixture of 4 parts of water and 1 part of turpentine. Add a small piece of soap Mix thoroughly so that soap is dissolved. Warm the mixture slightly before application Moisten the newspaper or magazine picture with it, place a white paper on it, rub the sheet hard with the back of a

spoon You will get a reasonably clear photocopy of the original.

(b) Image drawing · Place the object (say flower in flower vase) on the table near your drawing sheet. Hold your pencil in one hand and a glass sheet in the other The glass sheet is placed at an angle (to be adjusted till image is seen) near the vase and on the drawing sheet. Now you can draw the object as if you are tracing

6. Computer Graphics

6.1. Introduction

The term computer graphics means diagrams, figures, pictures and similar graphic material which we can see displayed on the screen of a computer picture monitor. The screen of a computer picture monitor is very similar to the screen of a TV set Many times even ordinary TV sets can also be used as a computer picture monitor A computer picture monitor is also known as a display monitor A display monitor can be colour or monochrome A monochrome monitor shows the graphics in black and white or in a single colour, often orange and black or green and black.

There are many ways of creating computer graphics. Depending on what we want to do, we can use any of the methods or a combination of the methods listed below.

6.2. Graphics Software

Write a computer program. If you are a specialist in writing programs, you can write your own program to instruct the computer how to generate your graphics. However, writing such programs is an extremely difficult and time consuming process There are easier ways of creating graphics, using ready-made programs.

Using a ready-made program: Special computer programs written by experts, specially for generating different types of computer graphics, i.e, charts, graphs figures, pictures, letters, numbers etc. in different colours, are readily available in the market. These programs are also known as graphics software. Graphics software can generate almost anything, starting from simple figures like circles, squares, straight and curved lines, charts, to very complex three dimensional animated colour pictures.

The process of making still pictures look like moving pictures is called animation. Cartoon pictures are good examples of animated graphics You can see three dimensional animated computer graphics in TV advertisements A good example of this, is the revolving globe before the 9.30 p.m. English News, in our TV.

Various kinds of graphics and animation software are available from computer companies under various trade names Some can create simple graphics and are quite easy to use, while others are very sophisticated but take quite a long time to understand and learn. Some of the well known trade names in graphics software are Lotus 1-2-3, CAD, Auto-CAD, MS-Windows, Graphics Gallery, Mac-Draw, Mac-Paint, TIPS, TOPAS, RIO, MIRAGE There are may more equally good software.

A software is called "user friendly" if the users find it easy to use Those who write computer graphics software need to think, how, even beginners can easily learn and use the software without much problem. Good graphics software allows you to create your graphics easily by allowing you to choose most of the things which you need while deciding on shape, size, position, line thickness, colour etc. Fig 143 shows a computer screen where the user has partially completed the work.

A tiger's face has been sketched in free hand. To complete the colouring, the artist now has to choose an appropriate size of brush from the icons (pictures) of "Brushes" which appear on the screen (bottom-left in this picture). This is done by moving a computer generated arrow (CURSOR) and placing it on the desired brush icon on the screen. Similarly, colours can be chosen by transferring a few colours likely to be required immediately, on the "Active Palette" (middle top) from the "Colour Palette" (top left, 5th row). The colour in actual use is shown in the window called "Active Colour" If the artist wants to "fill" a specified area with a chosen colour, the "FILL" function (top left Ist row) is to be chosen first using the cursor and then the appropriate colour is to be chosen before outlining the area on the screen which is to be filled.

Various styles (Founts) and sizes of alphabets and numerals can be chosen from a given list; sizes and positions of various parts of the graphics can be changed, parts or all of any graphics can be changed, parts or all of any graphics can be erased (ERASE function), stored (SAVE function) in memory by choosing the appropriate instruction through the cursor from the list (also called Menu) of functions appearing on the screen In case of any difficulty, one can choose the "HELP" function to get the detailed instructions on what to do.

6 3 *Graphics Hardware*

For generating graphics on the computer screen, special add on equipment like mouse, graphics tablet, light pen etc. are used. A computer graphics generation Fig. 145 system using some of these equipment (also called hardware) is shown in Fig 144. Fig 145 shows a graphics being created by a light pen. The mouse is a small box connected to the computer by a long cable. It moves on a smooth surface due to rotation of a smooth ball fitted at its bottom X and Y rotation of

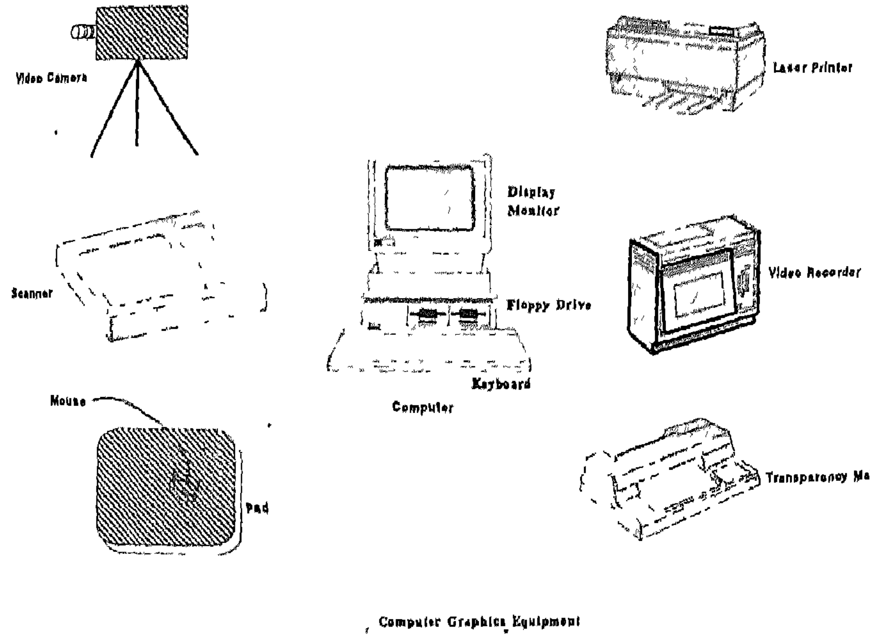


Fig 144 Computer Graphics Equipment

the ball controls the cursor on the screen.

It can create and transform images on the screen A graphics tablet has a 2-D grid of sensors in the form of an electronic drawing pad. Electronic stylus or pen is moved over it in the same manner as a pencil is moved over a diagram. The corresponding image is generated on the computer screen A light pen draws directly on the computer screen and the result is viewed immediately. It does not emit light but senses the light from the screen

The face of the tiger shown in Fig. 143 can be drawn by using either a light pen or through a graphics tablet It is also possible to bring in an existing picture or graphics on the computer screen This can be done by putting a picture through an equipment called a digitizer or a scanner which converts the picture into equivalent electrical signal suitable for the computer We can also use a video camera to capture a scene and through a special equipment display the picture on the display monitor

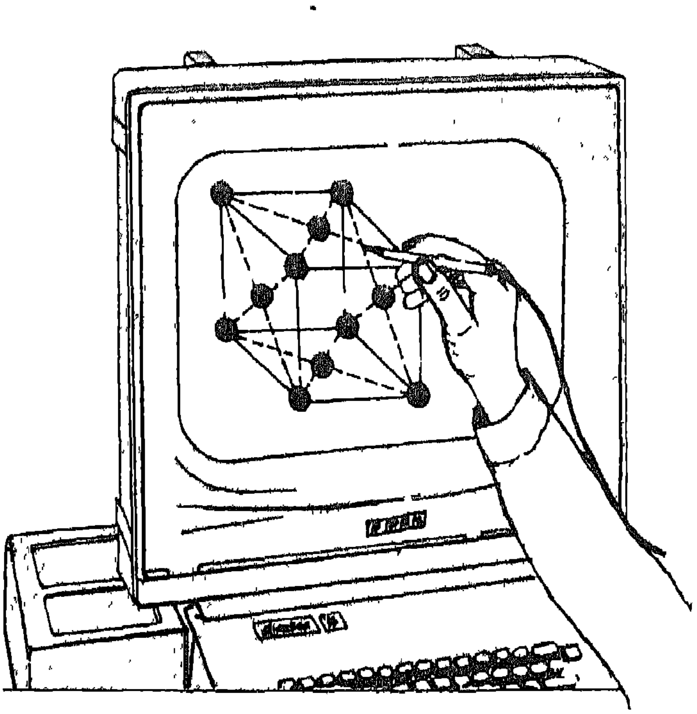


FIG. 145

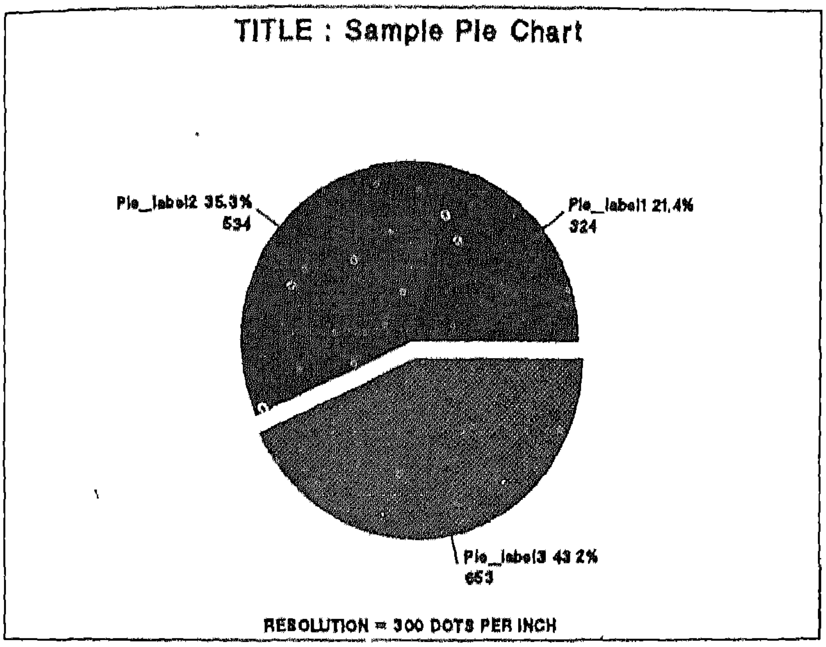
We can enlarge or reduce such pictures, or cut it into any given shape (using CROP function) and then add our own graphics on this picture

"Graphics software" which allow us to work in a simple way by offering a "Menu" of functions and do not require any specialised knowledge of computer or computer languages are sometimes called "menu-driven software".

It is possible to get permanent records of the graphics created on the computer, using special attachments. Various kinds of printers and plotters such as dot matrix printer, lazer printer, X-Y plotter can be used to get copies of the graphics on plain paper sheet. A thermoprinter can be used to get a copy on a clear acetate sheet suitable for overhead projection. One can use a special camera attachment to reproduce the graphics either on a photographic paper or on a transparency film (slide) Such permanent records are also known as hard copies.

6.4 *Pixels and Resolutions*

A picture on a computer display is made up of thousands of tiny phosphor



Computer Generated Pie Chart

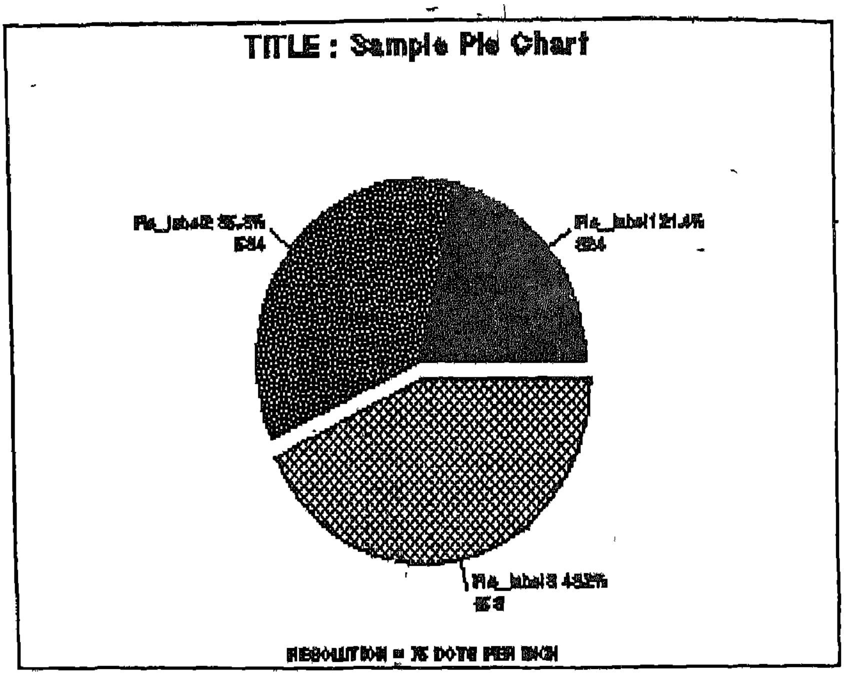
Resolution = 300 dots per inch

Note the cllarity in picture.

FIG. 146(a)

dots deposited on the inside of the front glass screen surface, the phosphor dots light up when an electron beam is made to hit them from the inside The creation of graphics is really nothing but writing a series of coded instructions to the computer which tell the electron beams which phospor dots it has to strike and when. The correct picture/graphics is created when the appropriate phosphor dots light up on the screen.

Depending on the requirement of picture quality, cost etc we may decide to have a very fine grained picture where we use each of the tiny phosphor dots as one picture element, or we may be satisfied with a relatively coarse grained picture where a block of phosphor dots is treated as one picture element. In short form, a picture element is often called a PIXEL. The larger the pixel size, the more coarse is the picture This is illustrated in Figs.146(a) and 146(b), which are hard copies



Computer Generated Pie Chart

Resolution = 75 dots per inch

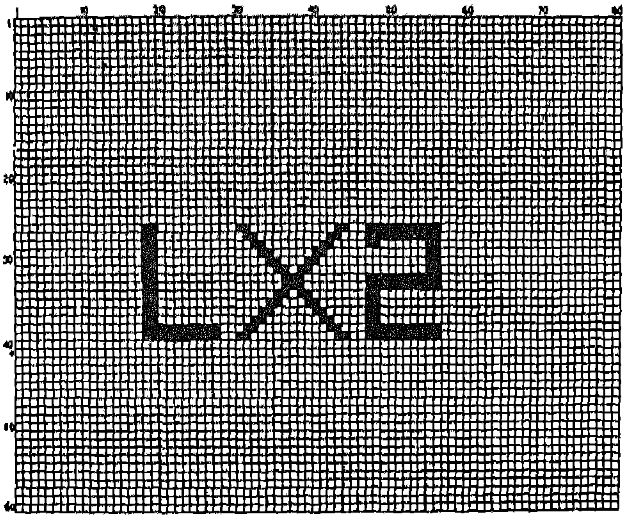
Note the coarseness of the picture.

The text part is ulmost unreadable

Fig 146(b)

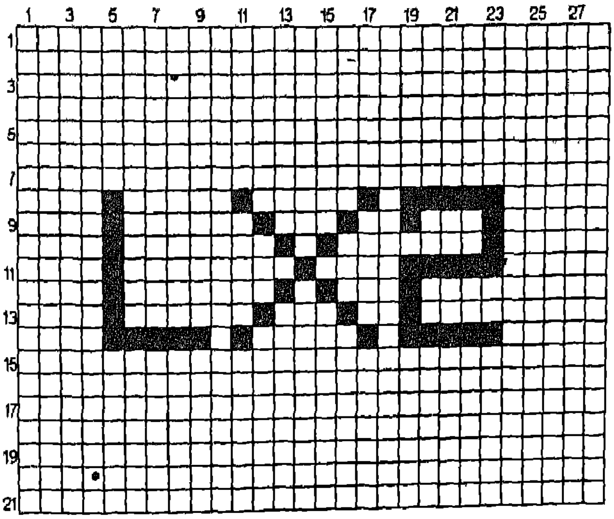
of a computer generated "Pie Chart" Fig.146(a) is printed with 300 dots/inch Fig 146(b) with 75 dots/inch. The increase in coarseness can be seen by looking at the quality of reproduction of curved edges and the texts.

The concept of pixel is further illustrated in Fig.147 and Fig. 148 In Fig 147 there are 28 picture elements in each row (horizontal direction) and there are 21 picture elements in each column (vertical direction) If you imagine Fig. 147 as a display screen, then the alphabets LX2 appear when we light up the appropriate pixels The exact co-ordinates of the different pixels which need to light up for the letter L in Fig. 147 are expressed as row and column number as shown below.



Resolution : 80 X 60 Pixels

Fig. 147



Resolution : 28 X 21 Pixels

Fig 148

For L, Row	8	9	10	11	12	13	14	14	14	14	14
Column	5	5	5	5	5	5	5	6	7	8	9
For X, $\frac{\text{Row}}{\text{Column}}$ = ?											
For 2, $\frac{\text{Row}}{\text{Column}}$ = ?											

You can work out the co-ordinates of X and 2. The letter X can be seen to have rough and jaggered edges in Fig 147(a) because of large pixel size Since there are 28 pixels in 3 125 inches in the horizontal direction, the resolution is approximately 8.96 or 9 dots/inch The vertical resolution is 21 pixels/2 625 inch or 8 dots/inch The edges become somewhat more smooth if we use larger number of pixels, each of smaller size to reproduce the same picture This effect is seen in Fig 148, where we have used 80 pixels/3.125 inch or approximately 26 dots/inch.

The term "RESOLUTION" is used to mean the ability of a display to reproduce fine details Higher resolutions need more pixels. Fig.148 has more resolution than Fig 147

6.5 *Graphic Display Adaptors*

- *Display Monitors:* Depending on the quality of graphics, one may use a cheap, medium resolution monochrome monitor, a more expensive colour monitor

- but with somewhat lower resolution or a very expensive high resolution colour monitor The type of graphics, from monochrome to all possible colours, from low to very high resolution graphics is called a multi-sync monitor.

- *Graphic Adaptors:* Just as we require a graphics software to generate computer graphics, similarly we require additional electronic circuits in the computer, to be able to display these on a display monitor. Such electronic circuits can be purchased separately as special graphics adaptor cards and can be fitted inside the computer. Different types of graphics display adaptors are available in the market Many times, the price of a computer may include the price of a particular type of adaptor card as a standard fitting. If we want a different adaptor card, the price of the computer may change to some extent We shall now discuss some of the common types of graphics adaptors very briefly

- *Monochrome Display Adaptor -- MDA/Hercules* . MDA in one of the two original adaptors introduced by the giant computer manufacturer IBM of USA around 1981. It is cheap and can display only texts in a single colour. The resolution is reasonably high, i.e. 720 pixels in the horizontal direction. The MDA can display upto 25 lines of text and in each line there can be a maximum of 80 characters.

The HERCULES was developed originally in Thailand around 1982 to display Thai alphabets on a computer screen using a standard personal computer (PC) This adaptor is capable of generating monochrome graphics with a 720X348 pixel resolution

- *Colour Graphics Adaptor—CGA*· CGA is the second type of graphics adaptor originally introduced by IBM, alongwith the MDA. CGA can be operated in one of two modes: 320X200 resolution with any two colours out of a palette of 16 colours.

- *Enhanced Graphics Adaptor - EGA:* The EGA card when first introduced by IBM around 1984 enhanced the graphics display capability of CGA to 16 colours out of 64 at 640 × 350 resolution.

  With a reduction in the cost of Integrated Circuit (IC) memories, by 1989, a standard EGA card was able to provide 16 colours out of 64 at 640×350 resolution.

- *Video Graphics Array Adaptor - VGA* The VGA, also introduced by IBM around 1987 offers a palette of 262, 144 colours Out of this palette, one can choose to display in any one of two modes: 256 colours at 320×200 resolution or 16 colours at 640×480 resolution.

- *Supper VGA/Extended VGA/VGA-Plus* · S-VGA was introduced by a group of display monitor manufacturers and computer board manufacturers called VESA, (Video Electronics Standard Association)

  The S-VGA introduced by VESA can display 16 colours out of 256, with a resolution of 800×600 pixels. Adaptor cards manufactured by companies other than VESA, are now available, which can display all the 256 colours with a resolution of 800×600 pixels.

  Other High Resolution Colour Graphics Adaptors. Around 1989 a company called Compaq introduced graphics adaptor cards capable of producing 256 colours at 1024×768 pixel resolution The display is non-interlaced

In 1987, IBM introduced for their PS/2 type computers (not the standard PC) a different adaptor called 8514/A adaptor. The 8514/A adaptor can display 16 colours with a resolution of 1024×768 pixels, but unlike the compaq the display is interlaced as with the graphics adaptors described earlier.

You have learnt new terms in this chapter Does each of the following term remind you of its association with graphics (on computer)?

display monitor, monochrome monitor, graphic software, icon, cursor, font, menu driven software, mouse, graphics tablet, light pen, animated graphics, user friendly, hardware, digitizer, scanner, dot-matrix printer, laser printer, x-y plotter, thermoprinter, hard copy, pixel, resolution, multi-sync monitor, MDA, CGA, EGA, VGA, S-VGA

If not, you need to read the chapter once more

If yes, consult the books mentioned in the References (13-16) for more information

7. Composition on the Display Board

The preparations required for creating an appealing composition has partly been discussed in the section under graphics Centre of interest should be distinct in the composition on the display board which should have simplicity with a balance of mass,

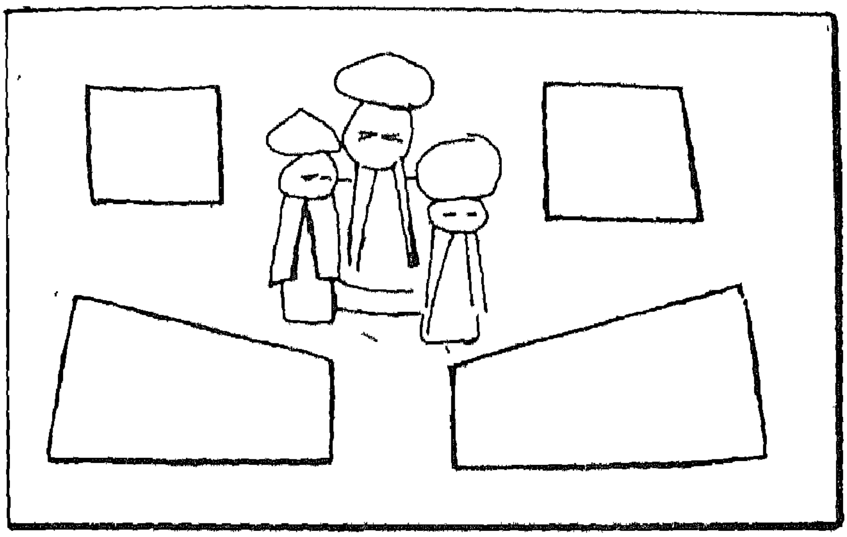


FIG. 149. Formal balance

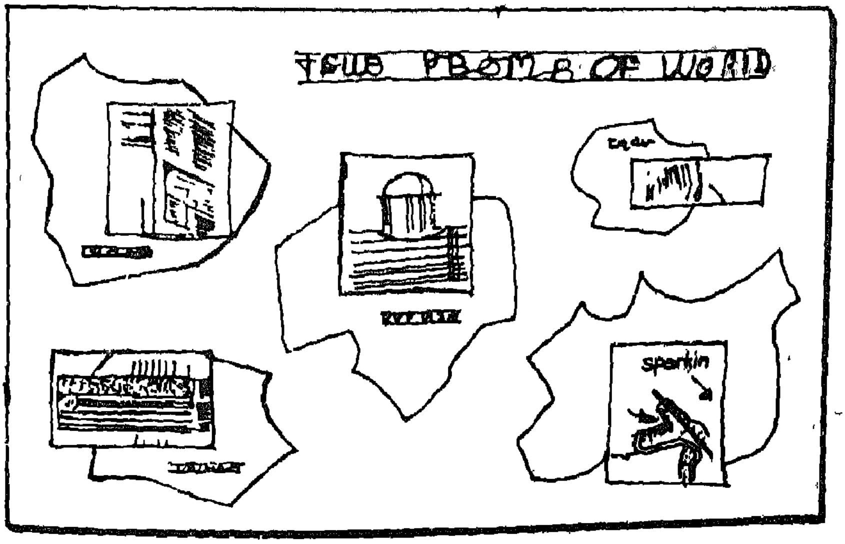


FIG 150 Coloured papers of irregular shapes are pasted around the pictures to bring prominence

line and colour. Afew examples of composition on the display board are given in Figs 149 to 154

They will serve as guidelines for the beginners.

8. Display Boards

Display board is of a size of 1 x 0.75 m or 1.5 x 1 m or 1.8 x 1.2 m the and made of wood (hardboard, ply etc), plastic or metal It is made detachable or fixed according to requirement.

Starting with chalkboard, various display boards are in use today, each having its own merit. Flannel cutouts are displayed on flannel board, felt boards are used generally for holding ply or hard board cutouts. Straw boards are commonly used for displaying visual materials which are of flat nature. Various types of boards are discussed below

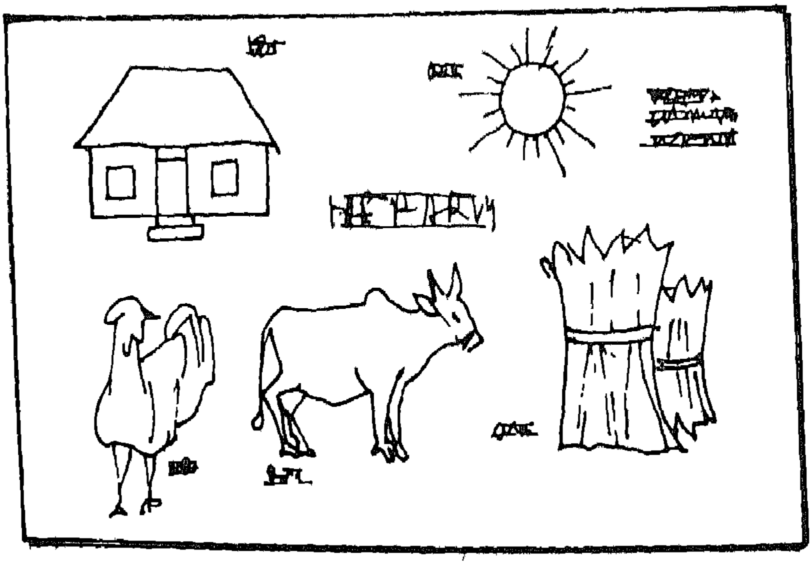


FIG 151. Use of cut outs

Chalk Board

Chalk board can be used as display board in certain situations though generally chalk boards are not recommended for display purposes in general Chalk boards (61 x 92 cm) made of special plastic sheet have been recently introduced. It is very light and portable (priced at Rs. 330 per sq m appox) Graphics could be pasted and displayed on the chalk board.

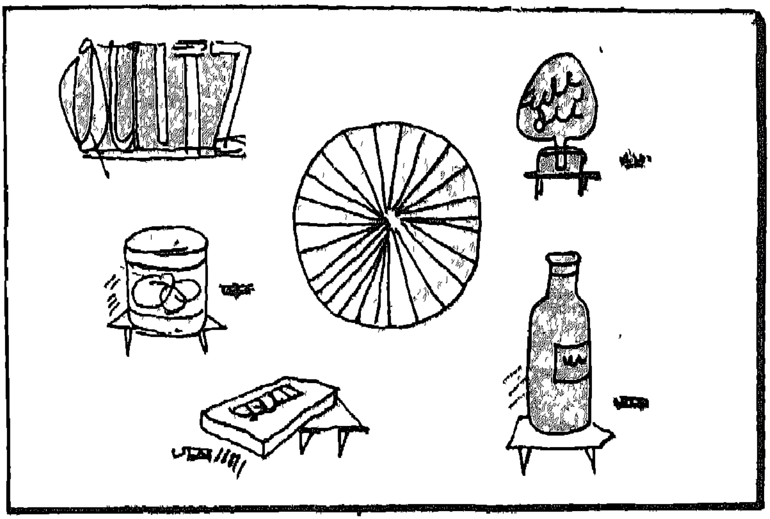


FIG. 152 Cut out of object and a quiz

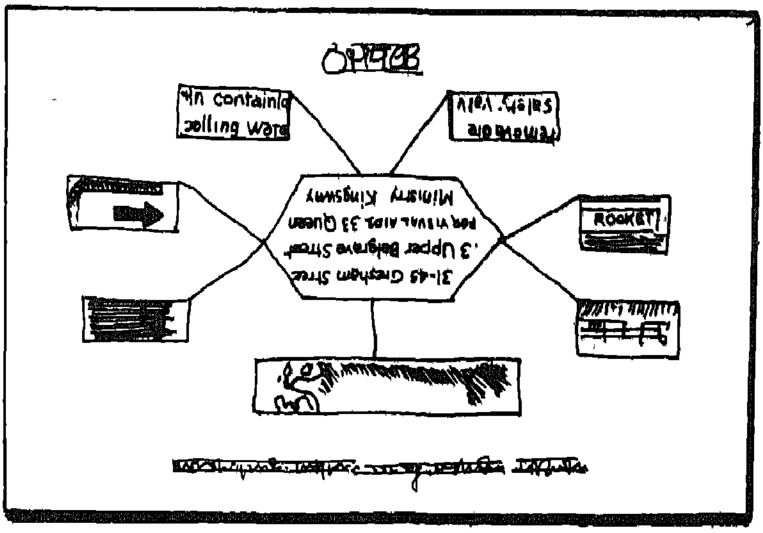


FIG. 153 Linkages among components of a system

Chalk Sheets

Wrapping paper or craft paper of good quality, poster paper, thin card or construction paper 55 x 70 cms are used. Fine blackboard paint or black varnish paint is applied on it with brush or a piece of cloth The sheet is dried after each

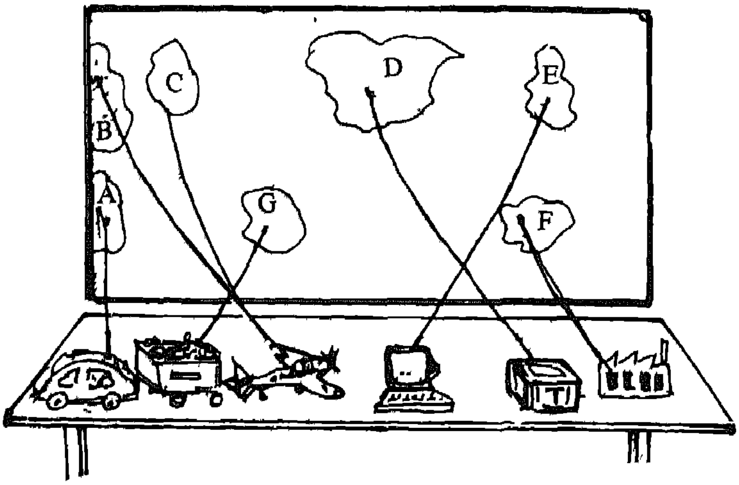


FIG 154

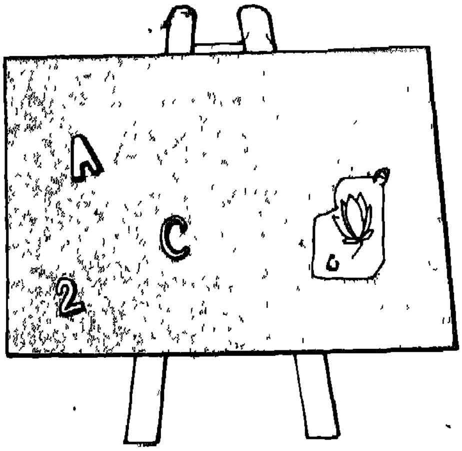


FIG. 155 Magnetic board

coating Atleast two coats are required. Compose text and sketches on the chalksheet with the help of chalk or crayon. Those can be wrapped and so are generally preserved for display, lecture etc.

We mean the same object when some of us call it "blackboard", others "chalkboard".

—How do you like to call it?

—Find out how does the contrast between black and white (white chalkstick on blackboard) compare with that of green and yellow (yellow chalk stick on dark green board)

—Find out the type of paint (black or green colour) which when applied on the board, will make an ideal surface for writing with chalk.

Magnetic Board

Metal sheet of any magnetic material can be used as chalk board. For this it has to be cleaned, framed and painted in green board or blackboard paint. Titles, charts, profiles etc can be very conveniently displayed with the help of magnets. Special letters or display materials with built-in light ceramic magnets are also available in the market which are used very conveniently. Long rubber strips impregnated with magnetic particles are also used on the board for holding sheets etc. in position.

Tag board

This is also known as peg board. This is made from hard board or masonite. It has small holes all over generally with a pitch of 25mm. Picture displays can be held on the board with specially designed clips. Model, book, specimen, apparatus etc can also be displayed on tag board. Hard boards of suitable thickness (3mm, 4mm or 6mm) may be chosen.

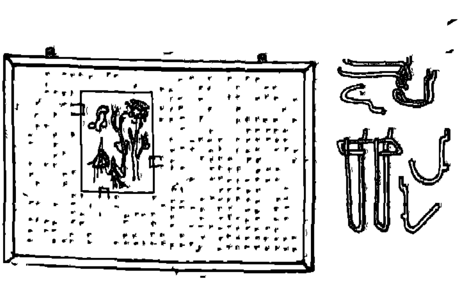


FIG. 156 Tag Board

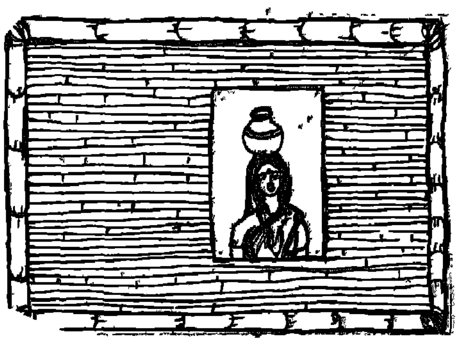


FIG. 157. Indigenous bulletin board from *munj screen* (Ref. 1)

Bulletin Board

This type of display board has a base of soft material so that exhibits etc. could be pinned. Common soft materials which are used on such boards are cork sheet, soft board, linoleum, coarse canvas, jute, hemp, venyl etc.

Low cost materials available in the environment could also be used for making bulletin boards. Soft fibre, munj screen, raw cane screen, coir mat mounted on plywood and then covered with khadi could be assembled locally without much expenditure. The size of 100 cm × 60 cms will be managable.

Prepare a bulletin board froom materials available in your locality. Use carpentry tools mentiomed in Chapter III.

9. Display Units

Panel materials are changing along with the change of technology. Wood is becoming costly and scarce and is bing replaced by varieties of plastic materials which have prominent advantages over wood as they are lighter and are almost unaffected by seasonal changes. Plastics are water proof and have favourable strength weight ratio. Various designs of display units given below are generally seen in national and international level exhibitions. They have modular construction so as to be assembled and dismantled very quickly; they can be packed and carried easily in one or more boxes generally of an approximate size of 1 m × 60 cm × 40 cm. All necessary parts, spares etc, are packed in the box.

Arrangement of panels can be set up in various orientations, e.g. X, T, H, etc. The exhibition area which is sufficiently large and covered need one or more types of display units as shown in Figs. 158 to 164.

Dispaly Unit 1

As shown in Fig. 158, cards or panels slide from the top of the three-part anodised aluminium frame. The structure can be folded and weighs nearly 5 kg Legs are removable, so that the panel could be used as a table topper also.

Display Unit 2 (Fig. 159)

In this display unit there are two basic components—panels locking devices (panelocks). The panels are 48 cm x 48 cm having light weight, plastic core sheets. The panels are in four coordinated colours. The locking devices are plastic discs with slots These lock panels together When dismantled the parts are carried in a box.

Display Unit 3 (Fig. 160)

This type of display unit contains pipes (threaded at both ends) of various lengths, balls having 2,3 or 4 threaded holes and panels The pipes can be joined together through the balls and geometrical figures like triangle, square, rectangle etc. of various dimensions can be created. The rods and balls are bright chrome-plated. The display materials can be pinned or fixed on the panel It possible to cover

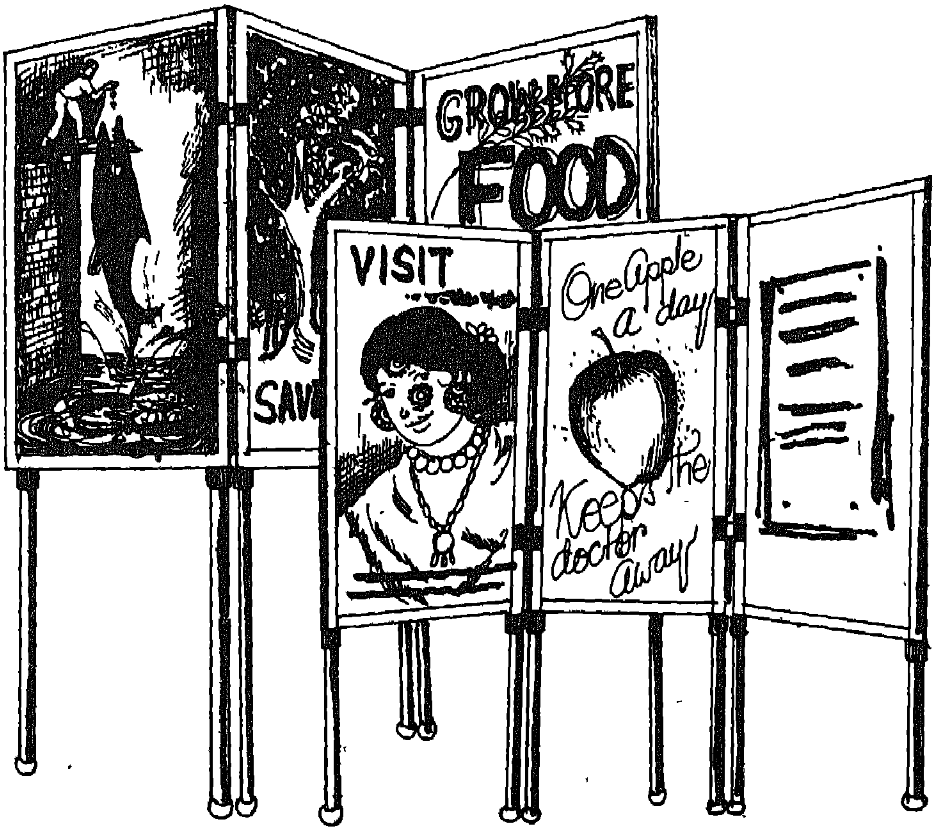


Fig. 158

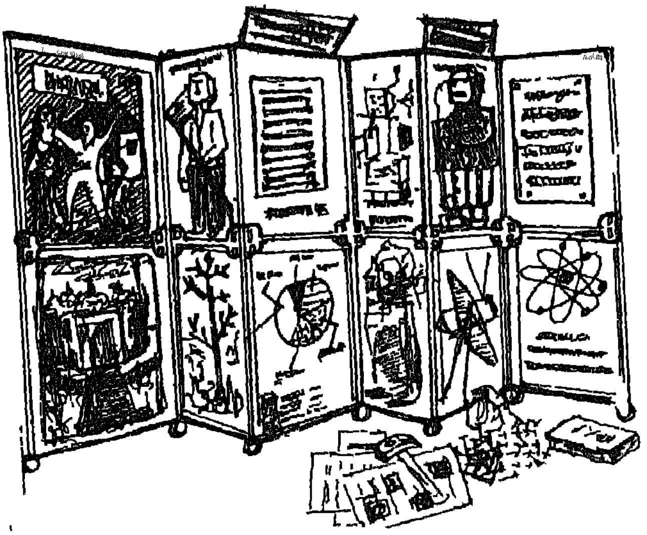


Fig. 159

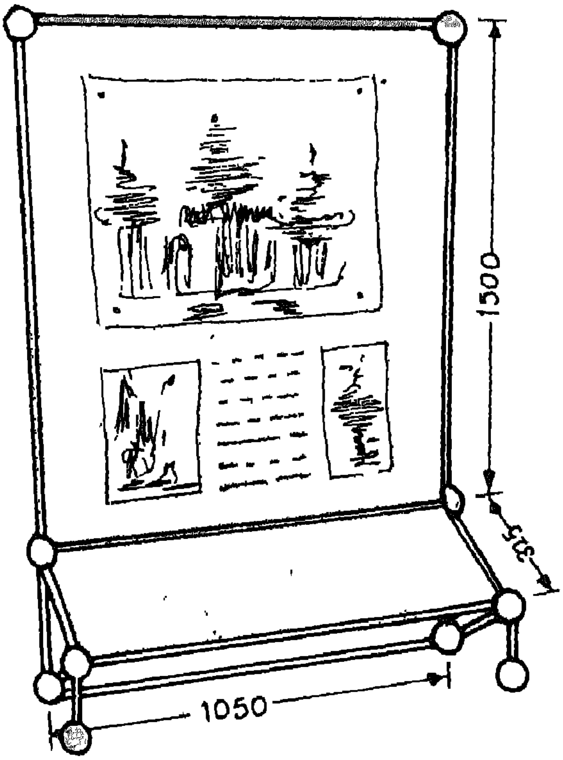


Fig. 160 (a)

very large display area with such modular display system The look is also very elegant

Diplay Unit 4 (Fig 161)

40 mm round aluminium tubing loaded with springs adjustable to various ceiling heights constitute the columns. The spring loaded tubes telescopes out of the top of the pole and exert pressure against the ceilling to make the poles firm The panels are placed in desired orientation.

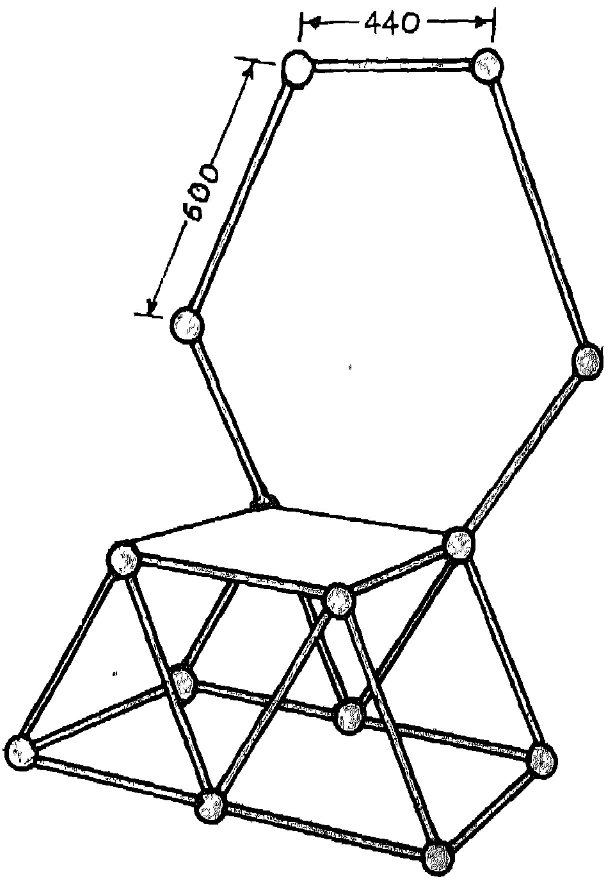


Fig 160 (b)

Display Unit 5 (Fig 162)

Here the panels have telescoping legs and are made of light plastic sheets; the framing and legs are of aluminium.

Display Unit 6 (Fig 163)

This unit has 1.2 x 1 8 m panels having aluminium frames Panels are made of masonite or peg board. The unit has a long sign board. The speciality here is the flexible connector (shown enlarged) This is made of rubber and has a few advantages over a hinge.

Display Unit 7 (Fig 164)

This is a free-standing exhibit system. Circular metal floor discs and aluminium tubing serve as uprights and cross members. Various connectors can be used for making various orientation possible brackets for shelving, 3 and 4 way connectors, light fixtures, panel hooks are the accessories to set up the system

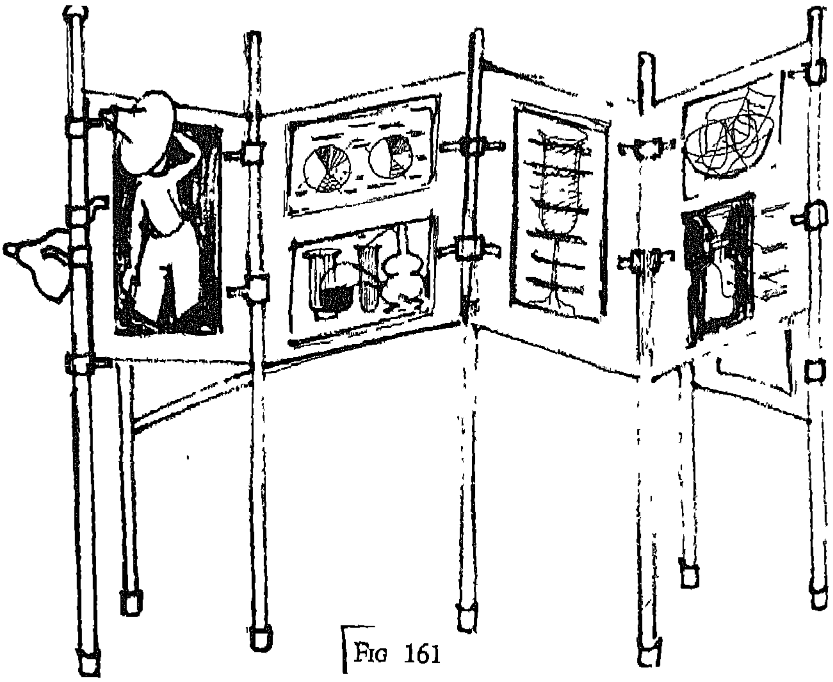


FIG 161

10. Lighting

The following types of lighting are generally used in illuminating exhibits. *Back lighting* is used to create a halo of light radiant from the perimeter of the background Care should be taken so that there is no direct glare in eyes of the viewer.

Light from below can be done for highlighting three dimensional objects. The lamp may be placed in opaque box, the top of which is a frosted glass. The light from below the object will not only illuminate it but also cast interesting shadow on wall behind the object. The box containing the lamp should have sufficient holes so that heat can escape

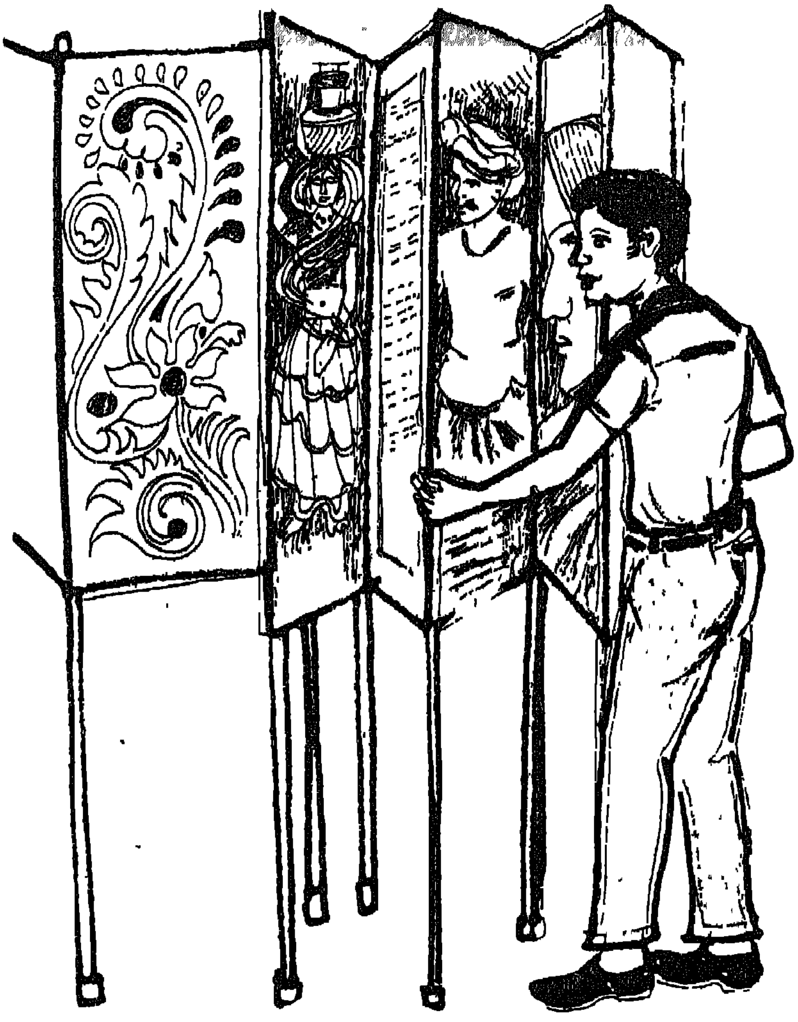


FIG. 162

Indirect lighting is to be insured always. The bulbs here are covered by valance or baffle so that there is no glare in the eyes of the viewer. The hidden bulbs at the top of the panel are directed to throw light downwards; sometimes floodlight at the foot is directed to throw light upwards.

Transparent light boxes are very useful for showing brightly illuminated colour picture The colour transparency is sandwitched between two pieces of plastics—the front is clear and the back is frosted. These plastic pieces are fixed in a box which is closed from all sides and has a bulb inside. There should be sufficient number of holes in the box so that heat can escape.(Fig 169).

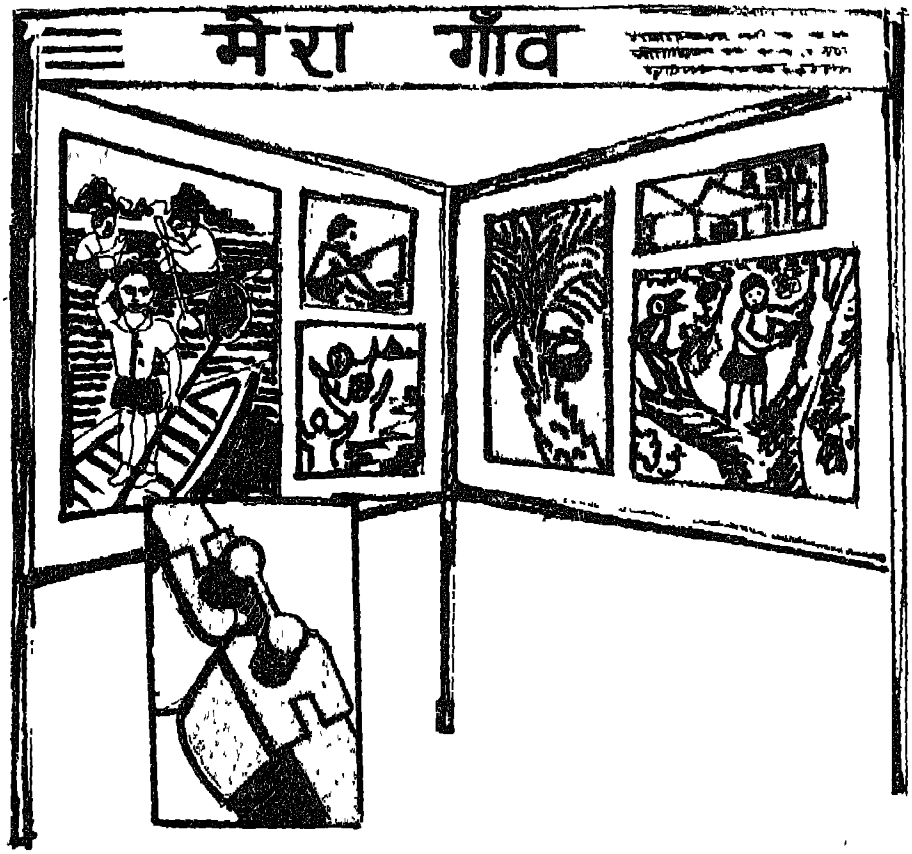


Fig 163

Spot light projects a circle of light on a single important element. *A flood light* is a non-focussing general light on a particular area

Ball light throws bright light half spot and half flood on a mannequin. (Fig 166)

Swivel head lamps are cylindrical, conical or bullet shaped; the lamp is mounted on swivel so that it can project light in any direction (Fig 167).

Clamp-on lamps with squeeze attachment can be clamped on to a shelf or an edge of a panel. As the lamp head can be swivelled, light can be directed according to requirements (Fig 165).

Picture Lamp which is in the shape of half round cylinder is used to illuminate

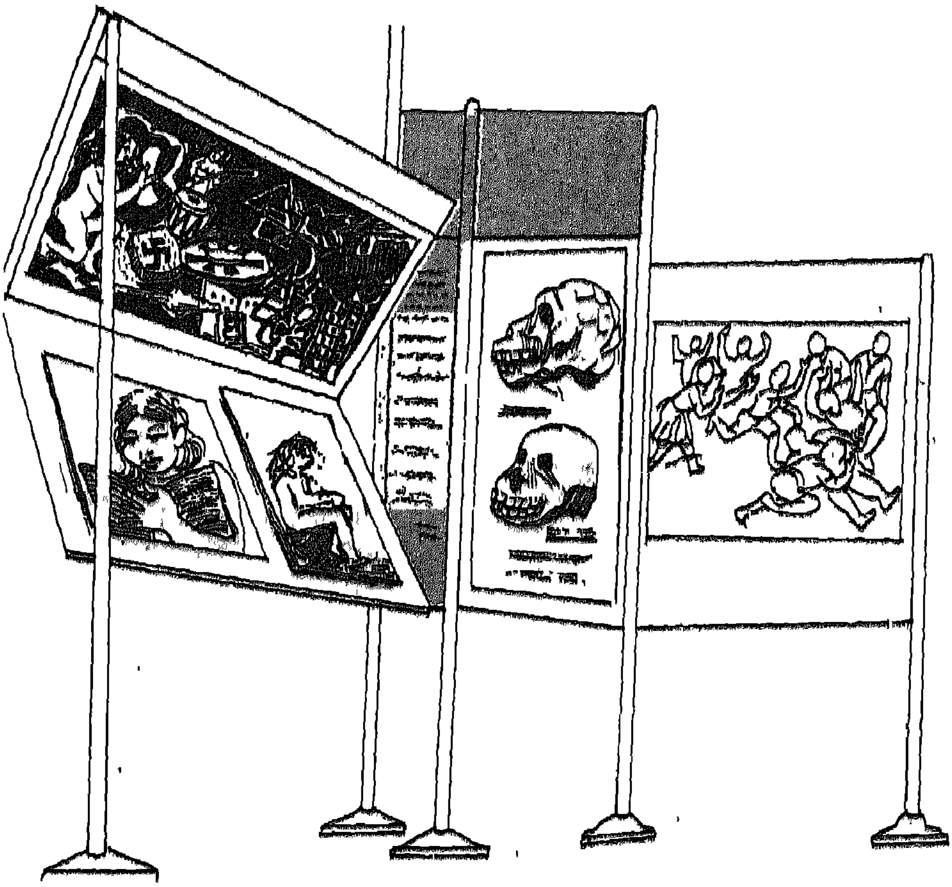


FIG. 164

paintings in galleries and to light up notation sheets on musician's stand.

Articulated lamps in the form of clamp-on or self-standing are used as table lamps or work lamps in studios. They have floating arms which provide flexibility of rotating the lamp in any plane (Fig 168).

Flasher makes a bulb or series of bulbs blink. You can procure blinkers from auto spare part shop. Don't use flasher unless it is absolutely necessary, because it annoys viewers if run continuously.

11. Mounting Techniques

Mounting of displays involving use of viscous liquids like rubber solution, quickfix, araldite etc. is called wet mounting.

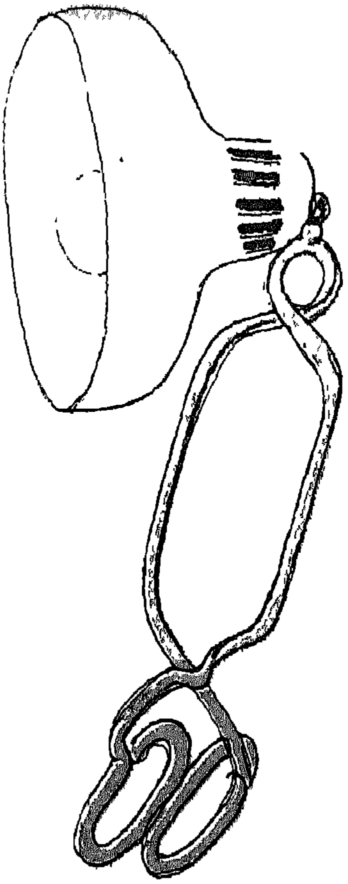


FIG 165. Clamp on lamp

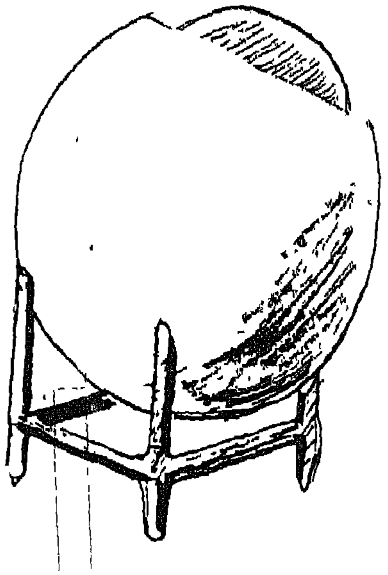


FIG. 166. Ball light

Rubber Cement

The best adhesive for mounting photographs, drawings, card board or paper is rubber cement or rubber solution. Materials mounted with rubber cement can be removed subsequently without tearing or spoiling. The bigger tube has a built-in brush applicator attached to the cap. As the rubber cement thickens when exposed to air the lid is to be kept tightly closed always. Let us consider the mounting of photograph on a panel. The photograph is placed in the desired position, its outline is marked lightly in pencil Spread a few drops of rubber cement over the marked area. Leaving these to dry, apply rubber cement on the back of the photograph When both the surfaces are dry the photograph is mounted, start with the two top corners and press them down. Entire face of the photograph will be uniformally pasted if you rub and press evenly Excess rubber cement can be rubbed off with fingers The wet rubber cement will peel off the paper when it becomes dry Rubber cement erasers are also available. You can also make your own rubber cement eraser by spreading some amount of rubber cement on a piece of paper, on drying it can be used to rub and lift other rubber cement. This is generally rubbed in one direction only—away from the edges of the photograph so as not to damage it.

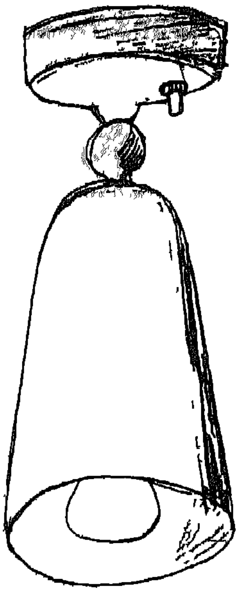


FIG. 167 Swivel head lamp

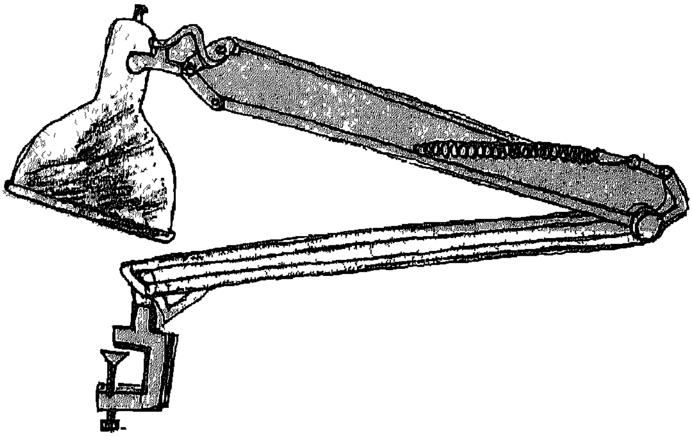


FIG 168 Articulated lamp

If you wish to remove the photograph after sometime, spill some thinner underneath one corner of the photograph The thinner will dissolve the cement For this you may dip a fine brush into the thinner and daub the corner of the photograph with the thinner until the bond is loose A razor blade in combination with thinner can do a nice job. If frequent removal of the same photograph is desired it will be convenient to buy a new unused oil can with a spout Drops of thinner from the oil can will gradually release the whole photograph starting from the corner After removal clean up the panel surface with the help of the eraser.

Quickfix and similar other materials including natural glues are also used in

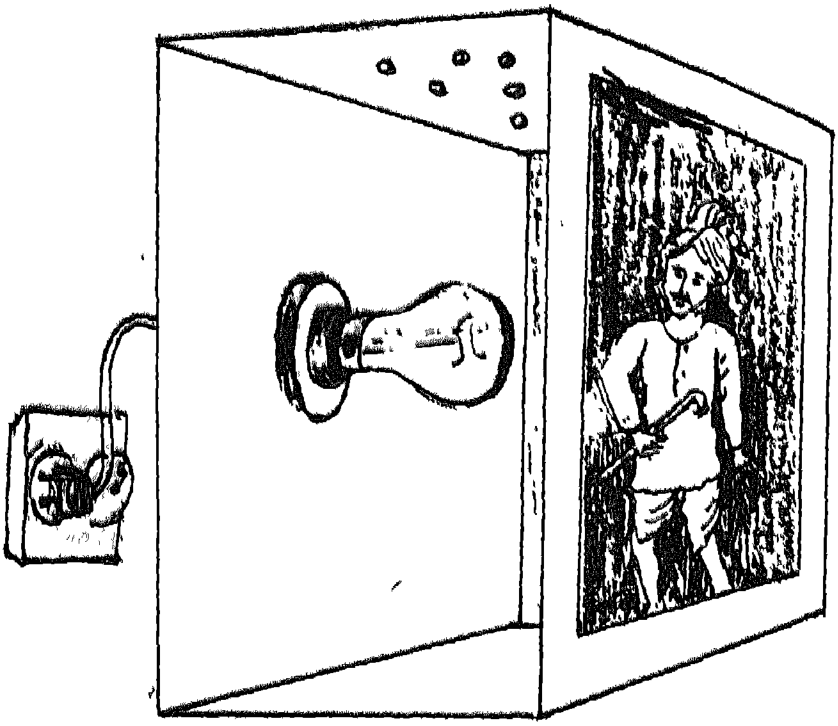


FIG. 169 Transparent light box.

mounting. The choice by and large depends on the experience of the artist. For mounting objects of glass or metal permanently, a stronger bonding agent is required. Araldite (adhesives and hardner) is one of the excellent adhesives for heavy duty permanent bonding. Read carefully the instructions for mixing adhesive and hardner given in the pack of such adhesives. Also refer to section 4 of Chapter III. *Wax heat mounting* employs wax as bonding material between the flat display and bulletin board.

Brochures, pamphlets, photographs are generally fixed up by dry mounting which employs one or more of the following materials.

- double back scotch tape which has adhesive on both sides.
- push pins (or thumb tacks) with plastic or glass heads which provide easy way to affix display panels.
- map-pins with coloured heads are cheaper but don't give the display a professional look.
- staple gun is the simplest and fastest means of mounting. Even small desk staplers can be used as staple gun by detaching its pedestal piece.
- other fastening materials are—peg board clips, gummed hanger groumet, paper clip, rolled masking tape, photo corners etc.

Reflector Lamps

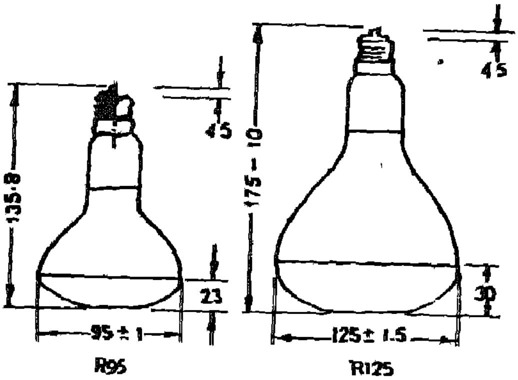


FIG. 170

Definition

Blown bulb reflector lamps with satin frosted front finish and high efficacy internal mirror reflector to achieve brilliant lighting effects.

Description

a) Satin frosted bulb finish ensures perfectly diffused light output.
b) Internal high efficacy mirror reflector gives high intensity beam without use of external reflector.
c) Available in flood as well as spotlighting versions.

Applications

Reflector Lamps 230V. 75W/100W/150W
a) Show window/display lighting in showrooms
b) Accent lighting in homes and Offices
c) Shops, restaurants and art galleries for high level local lighting as well as accent lighting.
d) Stage lighting.

Reflector Spot Lamps 24V. 150W
a) Spotlighting in show-window displays/exhibitions.
b) Maintenance Inspection areas, for hand lamps.

12. Moving Displays

Movement of the exhibits is sometimes essential for a better presentation. When mechanical movement becomes absolutely essential, an ordinary turn table is the simplest means to expose all sides of the exhibit. Turn tables driven by motors are also needed in many cases. Speed regulation of such motors should be considered before buying the same. Speed control through resistance should be aimed at wherever possible. Speed control through gearing should not be generally attempted. In some cases one has to adopt belt-pulley transmission. Various types of fractional horse power motors available in market may be seen at page 138

One of the cheapest ways to get rotation out of hot air is to fit a very light cylinder with illuminated art work around a bulb. The upper end of the cylinder has vanes made out of very thin metallic sheet. The centre of the vane is pivoted on a pin. Due to convection current of hot air from the bulb, the vanes rotate and the rotation of the illuminated art work is obtained very easily. The field of application of this method is very limited because of the light weight of the rotating parts.

—You have to show moving profiles of a few pre-historic animals on curved or flat screen (nearly 60 × 40 cm). Shadow of each animal will appear and disappear reasonably slowly. Think of the simplest possible design.

—make a rough sketch of your proposed design mentioning mechanism, materials, dimensions of parts, proposed paint and type and power of light source.

—prepare the model with the help of your teacher. (Also see Chapter III for information regarding electric motors, fabrication etc.)

13. Storing Flat Visuals Storing pictures and flat visuals is really a problem particularly when varieties of sizes are mixed up. To avoid this kind of problem, size of the flat visual should be standardised Base board or mount board of standard sizes are available in the market. Classify the exhibits subject-wise or size-wise; number them properly, record them on a paper and place them in a wooden or metallic box. This numbering will now help you to take out easily a particular visual without disturbing others.

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V

Types of Science Exhibition

This chapter will tell you about science popularisation programmes and different types of science exhibition in our country. You will be able to participate in those programmes and visit the nearest science centre.

Science exhibitions are held to popularise science by various educational institutions and organisations in our country. These may be broadly classified into:

(a) Temporary Exhibition (housed in temporary structure for a few days)
(b) Permanent Exhibition (housed in a permanent building and campus)
(c) Science Class on Wheels
(d) Travelling Science Exhibition, Museobus, Exhibition Van
(e) Science March, Street Play etc.

1.Temporary Science Exhibitions: Exhibition Site, Space and Exhibits

The exhibition site is selected by the organisers. Generally a field of the size of a football ground is necessary for display of nearly 150 exhibits and smooth movement of visitors One such layout is given in Fig. 171.

Each row of the pavilion is divided into small or big enclosures depending on how the organisers want to classify the exhibits. The smallest size of an enclosure is generally 3m × 3m while the largest size could be the entire ground. Each row is covered on three sides with the standard *kanat* and has *shamiana* resting on bamboo or wooden structure. Tarpaulin is used generally on the roof as a precaution against rain or storm.

The time for temporary exhibitions is normally selected on the considerations of school holidays, mild weather, special occasions etc. Obvious choice goes to winter months. The Jawaharlal Nehru National Science Exhibition is generally inaugurated on 14th November every year. The exhibition runs for seven or eight days. The exhibits are displayed in different types of spaces:

(a) Open space for open air exhibits and movement of visitors
(b) Covered space under temporary structure
(c) Covered space under permanent structure.

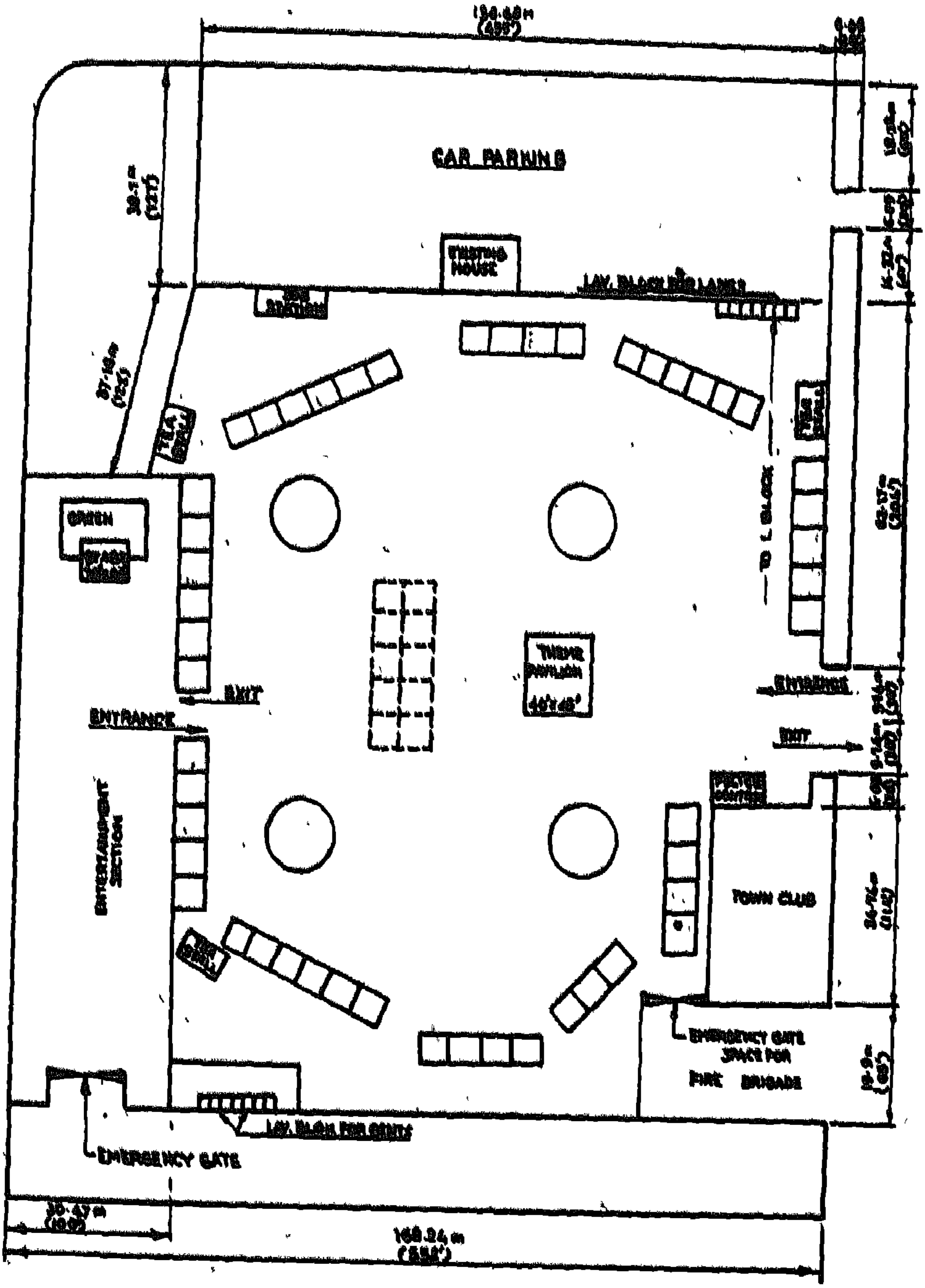

CAR PARKING
HOUSE
ENTRANCE
EXIT
ENTERTAINMENT SECTION
GREEN
TO L BLOCK
ENTRANCE
EXIT
TOWN CLUB
EMERGENCY GATE
SPACE FOR
FIRE BRIGADE
LAV. BLOCK FOR GENTS
EMERGENCY GATE
168.24 m
(552')
30.47 m
(100')

FIG. 171

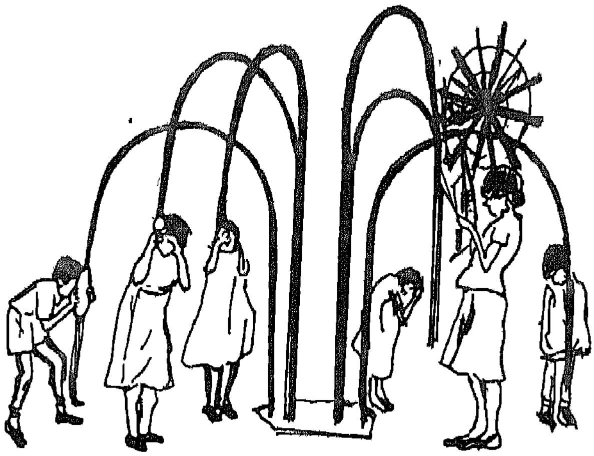


FIG 172 Optic tree (open air exhibit)

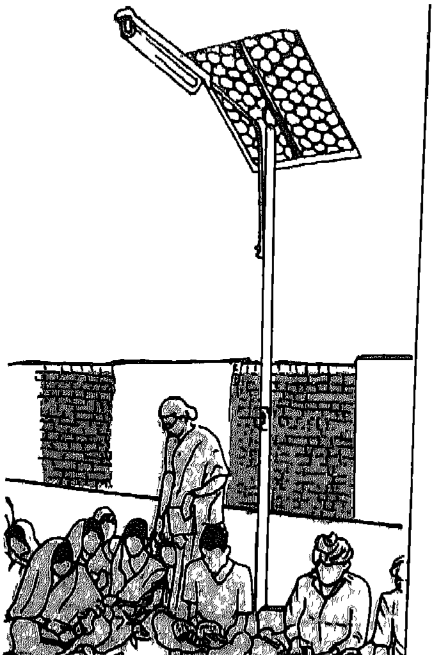


FIG 173 Solar panel (open air exhibit, with peak sunlight intensity of 100 mw per sq cm one 100 mm dia cell generates 1 watt at 0 5 volt)

The **open space** is generally used for exhibits which require uncovered areas and also give natural look in keeping with the environment of the place. For instance the natural habitat in a forest can very well be depicted with stuffed birds and animals in a green patch having trees and vegetation. Exhibits such as bullock cart, weather station, appliances using solar energy, generation of biogas etc. are displayed in the open only. Fig. 173 shows a solar panel which charges battery. The charged battery supplies energy to the tube light.

A typical **temporary structure** covered by tent materials is shown in Fig. 174.

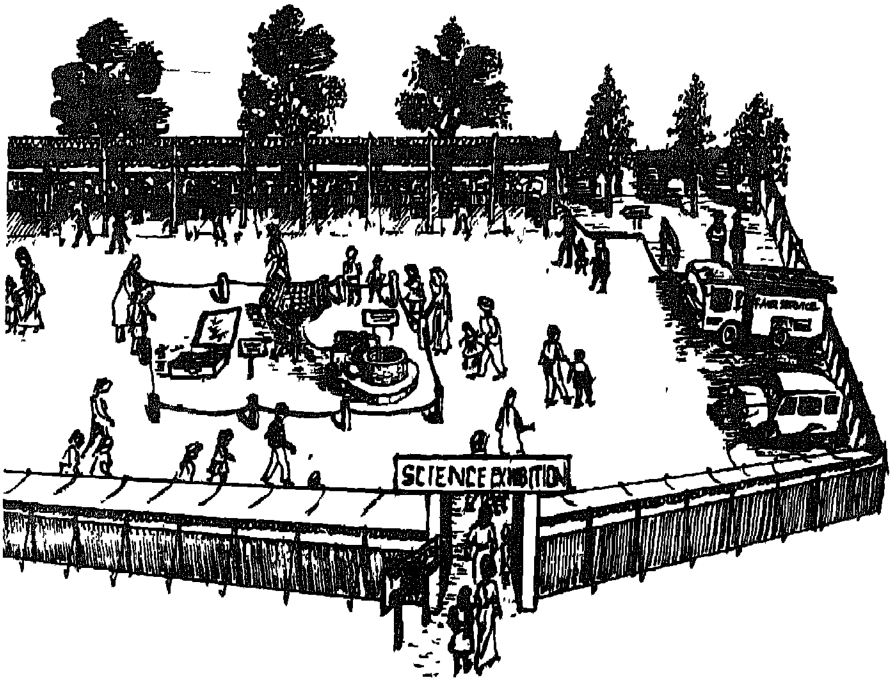


FIG. 174

The dimension of each enclosure is determined by the size of display table, number of exhibits, space requirement of the exhibits etc. This is the cheapest form of covered display space for an exhibition to be visited by nearly 5000 persons per day.

Some institutions and organisations have their own prefabricated display enclosures, display tables, panels etc. They are modular in construction, so that the parts can be quickly assembled and dismantled.

Sometimes **permanent structure** in the shape of halls or rooms are available at site. This type of halls generally has a high ceiling and is well illuminated and ventilated and has all essential facilities; the best example is the permanent exhibition facilities in the Pragati Maidan in New Delhi. While organising an exhibition in such a hall, the exhibits have to be classified and the passages have to be so designed that the visitors move quickly without crowding. Generally only one passage is kept which is made labrynthine intentionally so that the visitor can cover all exhibits enroute from entrance to exit.

In all these situations there are some common problems—dust, absence of steady flow of visitors and hence overcrowded passages, uncomfortable journey in the passage due to heat, humidity suffocation etc. Each problem has to be judged on its own merit and advance action is to be taken.

The following parameters (values are rounded up) will speak of the magnitude of the Jawaharlal Nehru National Science Exhibition

Number of exhibits	150
Number of participants per exhibit	2
Number of visitors per day	5000
Duration	8 days
Exhibition hours	7 hours each day.

The Urja Gram programme launched by the Deptt. of Non Conventional Energy Sources(DNES) offers package of integrated and decentralised energy systems at the village level. Before the Urja Gram project is taken up, energy survey of the village is carried out so as to assess the local resources like cow dung, biomass, wind,sun, agricultural residues and wastes. Urja Gram project has been implemented in 108 villages and 232 projects are being executed. DNES is maintaning the Energy Hall in the Pragati Maidan, New Delhi. It has an annual target of 24 exhibitions. These exhibitions provide attractive display of indoor and outdoor working systems and devices which are very attractive. Fig. 175 shows the exhibition get up of model Urja Gram as generally demonstrated in outdoor exhibitions. Such exhibitions are generally held at science centres, science museums and energy parks.

2. Permanent Science Exhibition

The permanent Science Exhibition (housed in permanent building and campus) is composed of various galleries and different sections like extension centre, children's corner, auditorium, library, workshop facilities etc. Each gallary is designed on a particular theme. Examples are transport gallery, galleries on fun-science, method of science, heritage etc. Each gallery is again divided according to various sub-themes each of which has topics supported

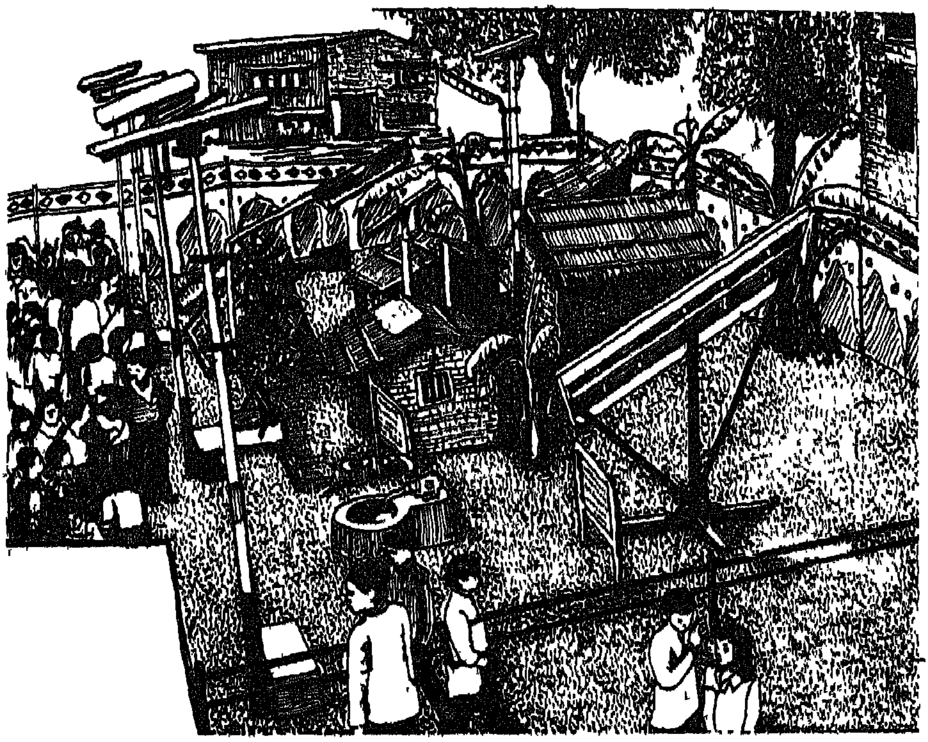
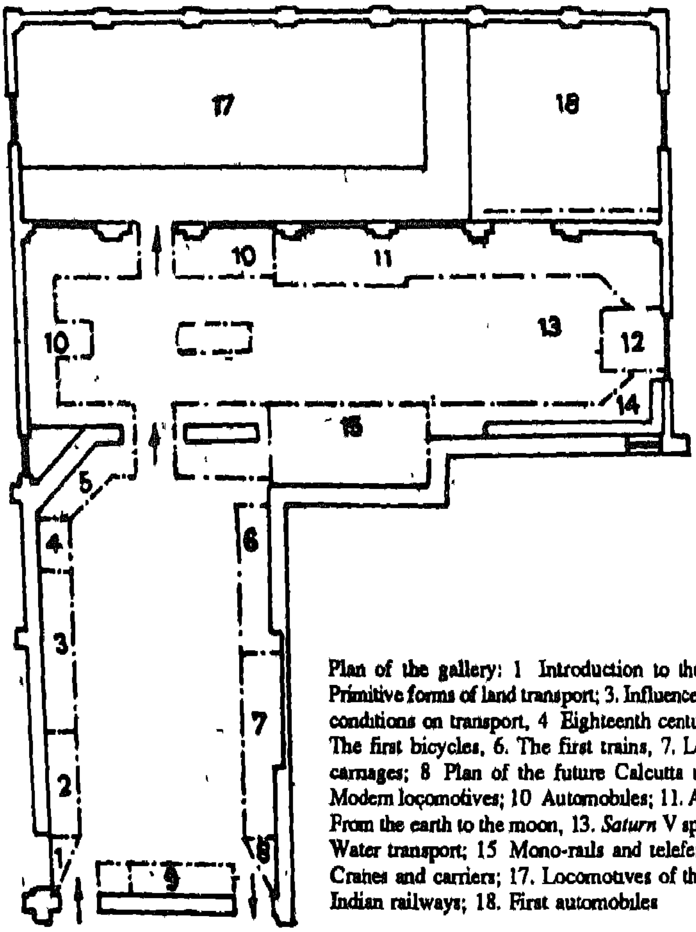


Fig. 175 Exhibition get up of Urja Gram (Ref. 9)

by exhibits. A visitor is guided through a gallery in a particular sequence in such a manner that he can learn with the help of suitable visuals, interactive models etc. A professionally designed gallery offers the visitor an updated structured information during his journey from the entrance to exit; this leaves a permanent impression in his mind, Fig. 176 shows the plan of the transport gallery in the Birla Industrial and Techological Museum, Calcutta(BITM). This gallery occupies an area of 350 sq. m and is distributed in three halls. The number of museums and science centers of NCSM have been shown in Fig. 177.

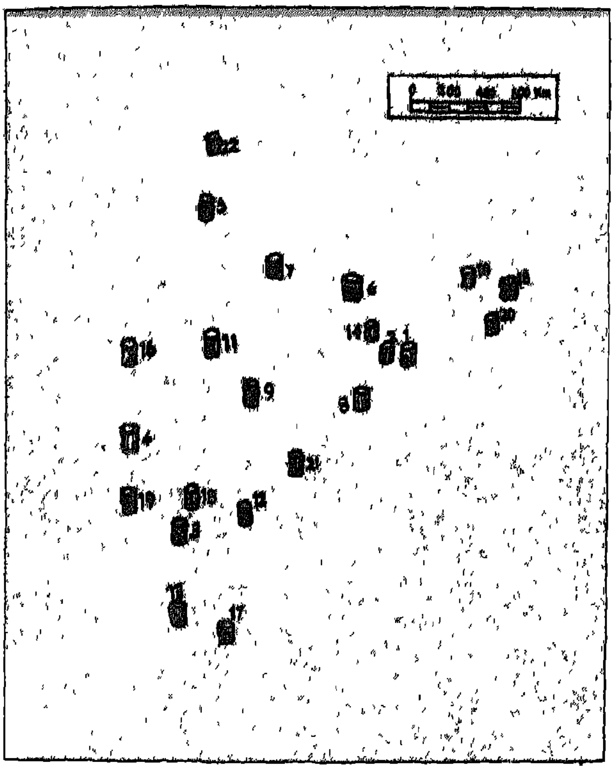
BITM-Calcutta is the first technological museum in India. Now it is setting up 'Animalorium' which will include snake park, aquarium and rabbit park. It will also be opening a butterfly garden. These are aimed at rekindling human interest in living beings and the importance of environmental protection.



Plan of the gallery: 1 Introduction to the exhibition; 2. Primitive forms of land transport; 3. Influence of geographical conditions on transport, 4 Eighteenth century, Calcutta, 5. The first bicycles, 6. The first trains, 7. Locomotives and carriages; 8 Plan of the future Calcutta underground; 9. Modern locomotives; 10 Automobiles; 11. Air transport, 12. From the earth to the moon, 13. *Saturn* V space vehicle, 14. Water transport; 15 Mono-rails and teleferic systems; 16. Cranes and carriers; 17. Locomotives of the narrow gauge Indian railways; 18. First automobiles

FIG. 176 (Ref. 3)

Besides NCSM various other organisations and institutions have permanent science exhibitions Birla Museum—University town of Pilani, National Museum of Natural History—New Delhi, numerous science centres, Bal Bhavan Kendras, planetaria, zoo gardens, aquaria, science parks dot the map of India. You must visit the nearest ones along with your friends and members of your family. These centres have, besides permanent exhibitions, programmes of demonstration lectures, teacher training, popular lectures by scientists and technologists, film shows, special programmes like sky observation, contemporary science etc. You should also establish contact with such organisations and institutions.



1. NCSM Headquarter, Central Research and Training Laboratory, Calcutta
2. Birla Industrial and Technological Museum, Calcutta
3. Visvesvaraya Industrial and Technological Musium, Bangalore.
4 Nehru Science Centre, Bombay
5 National Science Centre, Delhi
6 Shrikrishna Science Centre, Patna
7. Regional Science Centre, Lucknow
8 Regional Science Centre, Bhubaneswar
9 Raman Science Centre, Nagpur
10 Regional Science Centre, Guwahati
11 Regional Science Centre, Bhopal
12. Regional Science Centre, Tirupati
13 Regional Science Centre, Calicut
14 District Science Centre, Purulia
15. District Science Centre, Gulbarga
16. District Science Centre, Dharampur
17 District Science Centre, Tirunelveli
18 Sub-Regional Science Centre, Imphal
19 Sub Regional Science Centre, Goa
20 Sub Regional Science Centre,Aizwal
21. District Science Centre, Vijayawada
22. District Science Centre, Shimla

FIG. 177 (Ref.4)

3. Science Class on Wheels

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NCERT developed three mobile science vans during 1972-73. For this Dodge B-300 (Sportsman) van was used The facilities of a retiring tier for one person, seating arrangement of three persons and packing, of equipment were suitably fabricated on the consideration of economy of space,easy and quick packing and unpacking. The equipment (generator, 16mm movie projector, tape recorder, books, charts, kits etc) and exhibits broadly facilitated the following:

(i) all classroom demonstrations at the elementary school level

(ii) demonstrations for adult science literacy
(iii) extension of teacher training so that a primary school teacher can handle a science programme.
(iv) improvisations in experiments with the help of different low-cost materials and tools.
(v) Use of films and slides

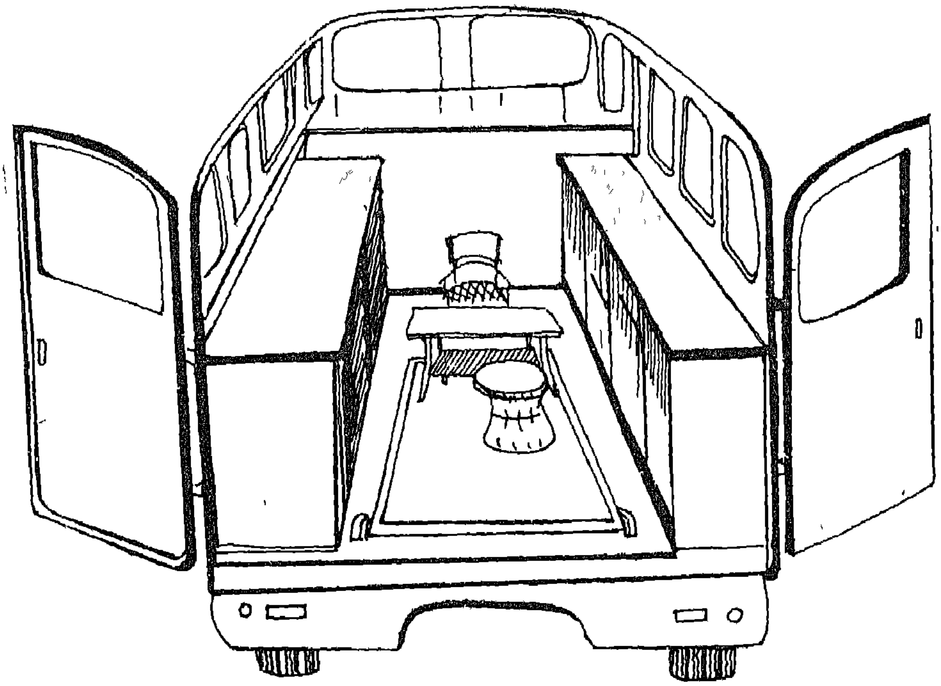

FIG 178 General arrangment in the van

These vans were used in tryout programmes in schools of the neighbouring villages of Uttar Pradesh and Haryana Both the project (the then Science Education Project) and non-project schools were covered. Whereas in-service teacher training programme was introduced in the non-project schools, the project school teachers had the exposure to subsequent cycles of teacher training. Later on the three vans were transferred to State Institutes of Science Education

The fourth van was developed on the basis of the feedback of tryout of the first three vans More flexible arrangement with space economy, easy but quick material handling were the speciality of this model of 'science Class on Wheels' This was specially designed to suit the requirement of schools in remote areas which do not have requisite equipment, laboratories, electricity or even permanent building

This Van was built on the FC-160 Mahindra (Bombay) Jeep chassis. It was divided into two compartments separated by sliding glass screens The first compartment (the driver's side) had·

1 a petrol driven 2 kW generator;
2 a motor with centrifugal pump;
3 a wash basin;
4 a set of handtools, including those required for repairing and maintaining the van;
5 the master of the intercom set;
6. a transparent stage for writing/working in (between the driver's seat and the helper's seat);
7. a driver's drawer for keeping maps & papers along with an arrangement for a working dining space.

The generator could be run inside the van as fitted or outside the van, as and when required. The electricity of the generator is mainly required to run the film projector and centrifugal pump with a transparent casing which was specially designed to·

(a) show the working principle of such pumps with the help of a stroboscope
(b) lift water to the overhead tank
(c) spray water through a nozzle for washing the van.

The rear compartment had back entry. As one enters from the back, he finds a hinging bed on the left. This was fitted in such a manner that when it was lifted, the set of science kits and film projector packed underneath with rollers and rubber pads were unlocked for being taken out.

The kits and the composite box for projector, speaker, transformer, films and switch box had universal rollers so that they could be handled very easily. On the right-hand side, racks with sliding glass/PVC partitions are fitted The first rack contained all relevant books and manuals including the maintenance instructions for the van Other racks contained the tape recorder, a high power microscope,rock and mineral samples, charts, electronics kit, different models including vacuum formed anatomy sheets(these could be displayed from inside the glass windows). There was a long box, fixed on the top of these racks, which contained the roll-up screen for the projector and other long components. In between the left hand bed and the right hand row of racks there was a hinging platform. The platform was used at the time of demonstration. The kits-on-rollers could be taken on it for demonstration. The plat form-on-rollers could be detached from the van and used as a trolley for handling kits or projector. There was a sliding canopy at the rear

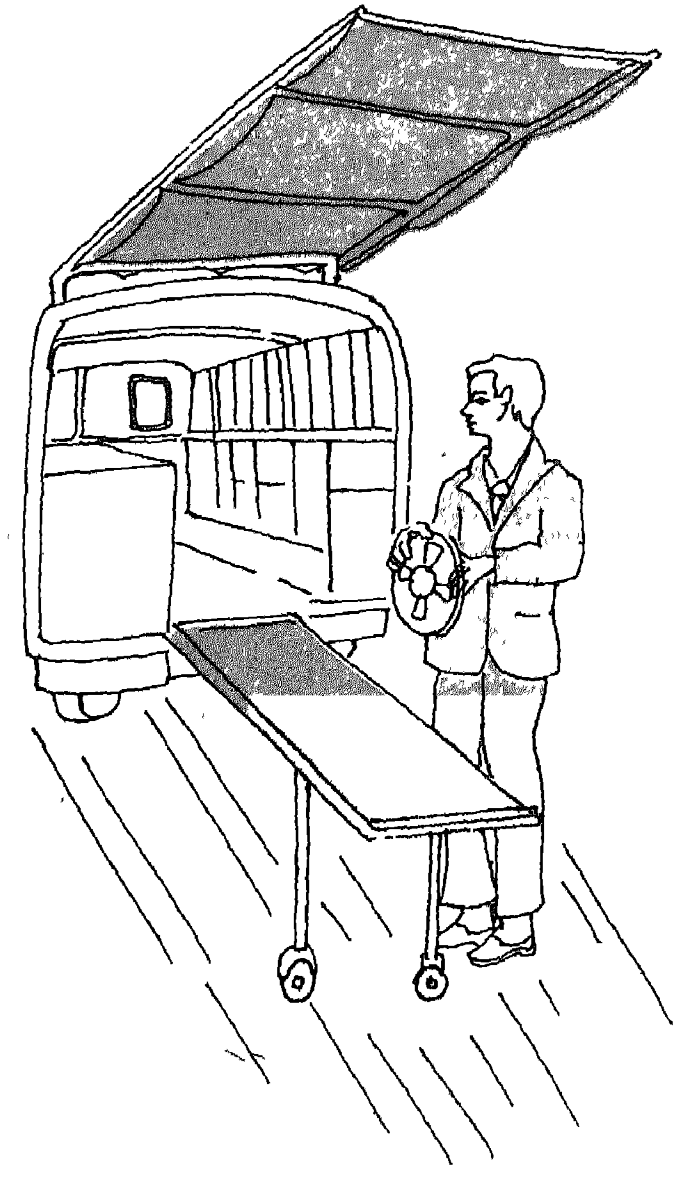

FIG. 179 Handling Projectors Kits

of the roof This was a sunshade for the demonstrator who used the platform as his demonstration table. A9'X6' tent, stored in the van, could be fitted at the side of the van. The tent could be used for many purposes, particularly for setting up a mini-workshop with the help of all the necessary hand tools available in the van. Two cushion puffies, one folding chair and a multipurpose table were put in the

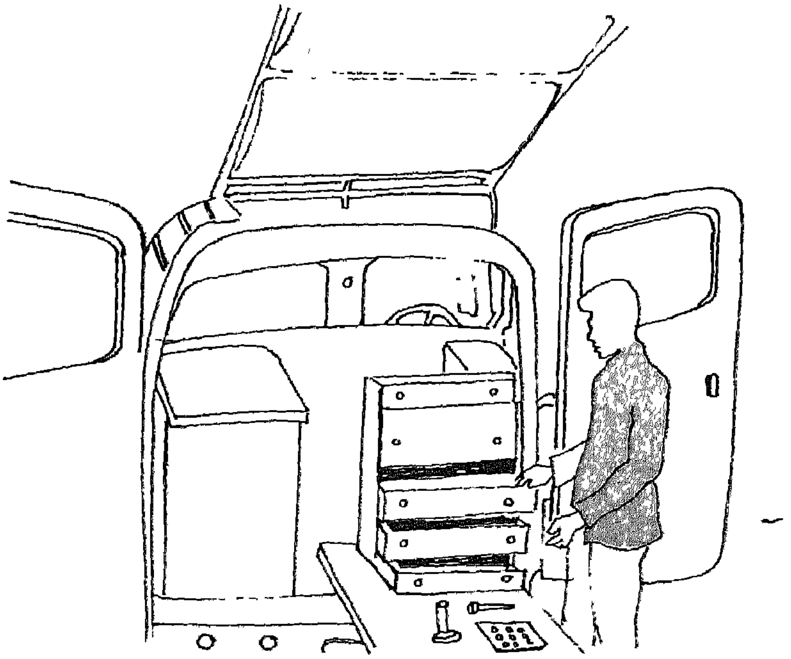

FIG. 180 Demonstration/lecture with apparatus/kit

same compartment. They were very light and sturdy. Working models of an I.C engine, steam engine and siren were fitted conveniently near the back entrance The inside arrangements were made to suit the convenience of the mobile staff, i.e. one lecturer, one driver-cum-projectionist and one helper The detailed list of items in the science van is given in the Appendix - V

This van was displayed in the National Science Exhibition-1973 held on the lawns of Teen Murti Bhawan. Smt. Indira Gandhi, the then Prime Minister took keen interest in it and finally it was donated to Bangladesh (28 October, 1974).

4. Travelling Science Exhibition and Museobus

4.1 Travelling Exhibitions

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Launched by the Victoria and Albert Museum, London for the first time in 1850, the travelling exhibition has been receiving increasing popularity It was introduced in Canada in early twenties followed by United States, South Africa, Australia. After 1945 many countries adopted this. UNESCO brought out a publication entitled 'Manual of Travelling Exhibitions' in 1953. In fifties significant

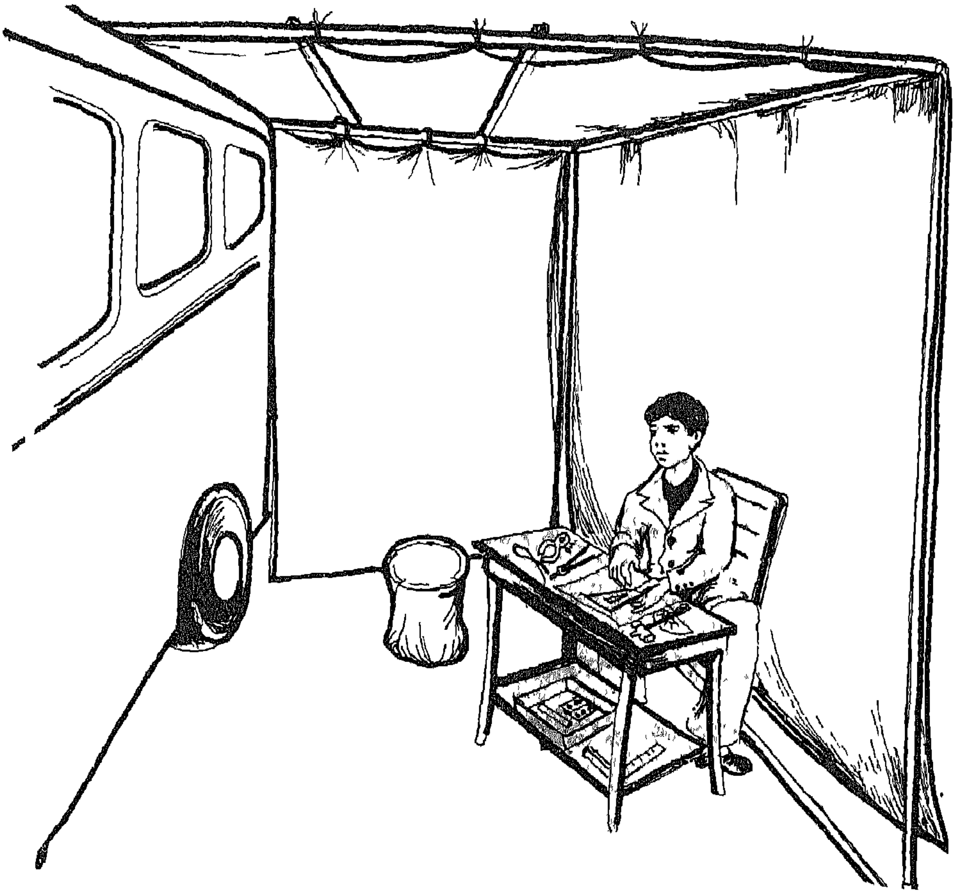

Fig 181 Tent Facility

developmental work in techniques, assembly, display, packing, transportation etc were done in many countries Between 1950 and 1959 UNESCO prepared a few 'Travelling Science Exhibitions' The themes were our senses and knowledge of the world, 'energy and its transformation,' 'man measures the universe', 'new materials' Stock of contemporary developments were taken by yet another UNESCO publication in 1963 entitled 'Temporary and Travelling Exhibitions' In India the first ever travelling science exhibition with the theme 'Our Familiar Electricity' was arranged by BITM, Calcutta in November, 1965. Artifacts, models, replicas, dioramas, instruments, demonstration equipment etc which form the travelling exhibition were specially designed alongwith suitable cabinets and display stands to suit Indian conditions

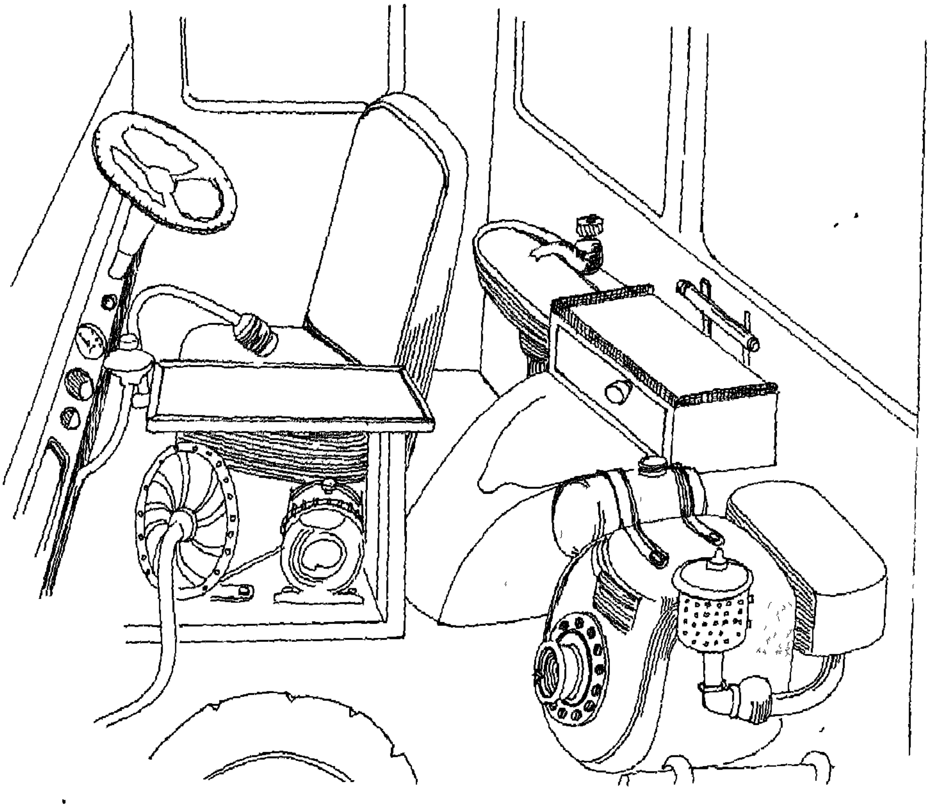

FIG. 182 Driver's compartment with generator, centrifugal pump, wash basin and table

Travelling exhibition materials are modular in construction and very portable These factors cut down the setting up as well as winding up time Fig. 183 shows the construction of a foldable display stand to house a cabinet These units are joined in series to form U Each exhibit is displayed in a cabinet of approximate size 93 mm × 734mm × 300mm (39" × 29" × 12") 28 such exhibits can be accomodated in a 2-ton truck having a loading area of 4572 mm × 2134mm (15" X 7"). The truck goes to a preappointed public hall where exhibits are displayed.

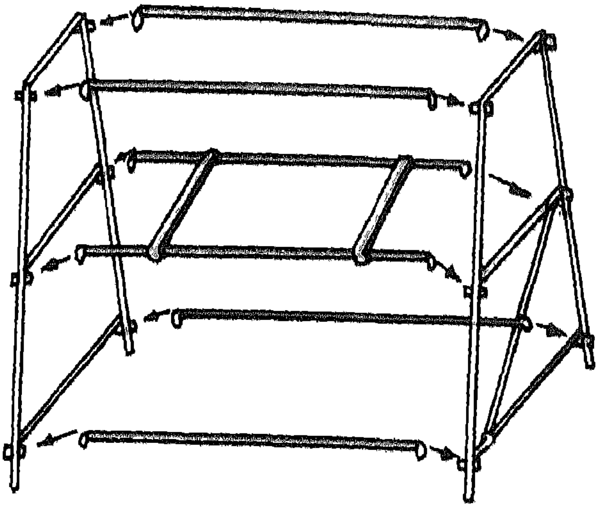

FIG. 183 Foldable display stand for travelling exhibits (Ref. 2)

It takes nearly two hours to set up the display. The small truck can also cross an unbridged river on a country ferry boat. The travelling exhibition can bring to the doorsteps of villagers new technology and appliances so as to modernise the cottage industry and help the artisans. It can even give the villagers the opportunity to observe a planetarium. This was beyond imagination even two years ago. Now an inflatable planetarium can be set up anywhere.

On the lines of the big planetarium, the inflatable version can also show a particular star, simulate real sky for a particular place and time, move the sun and planets. It weighs 36 kg and has a height of 3.2m (10'6"). Essential parts are—inflatable dome (clear floor space 6 m x 7 m accomodating 20 adults or 30 children at a time), blower fan (80watts), projector (100 watts), star field projection cylinder, earth cylinder, slide projector, slides, pointing torch, power board (220 AC), spares.

The travelling exhibition also run educational programmes in modern tents. Discorvery dome is a new structure. It is very attractive, allows natural light, has metallic frame and special plastic sheet covering. This is used in European countries where nearly fifty participatory exhibits are displayed for interaction. The dome is in fact a circus tent which moves from place to place. Due to its versatility and wide scope, the travelling exhibition scores over the museobus in some respects.

4.2 *Museobus*[2]

(a) NCSM mobile science exhibition: Some experts differentiate between

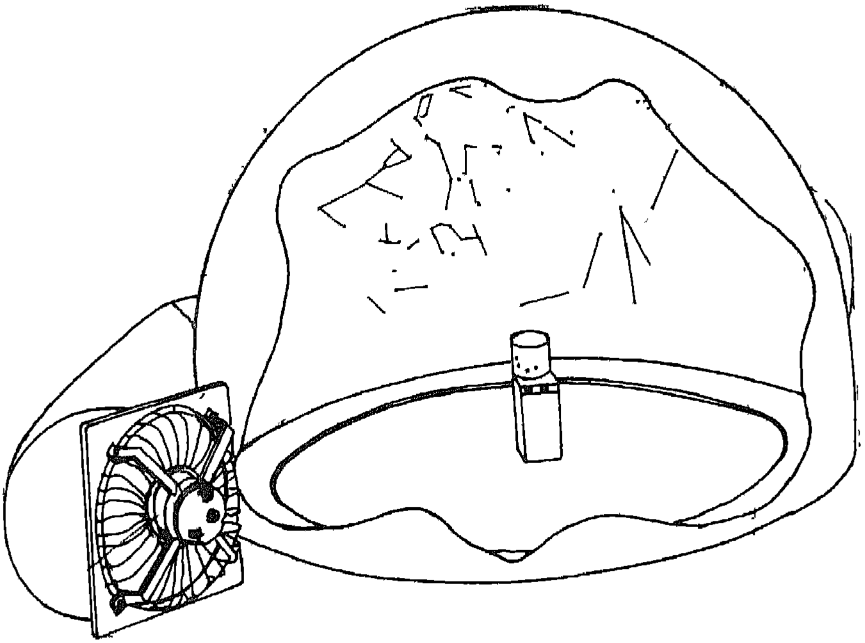

Fig. 184 Cut-view of Inflatable Planetarium (Ref. 5)

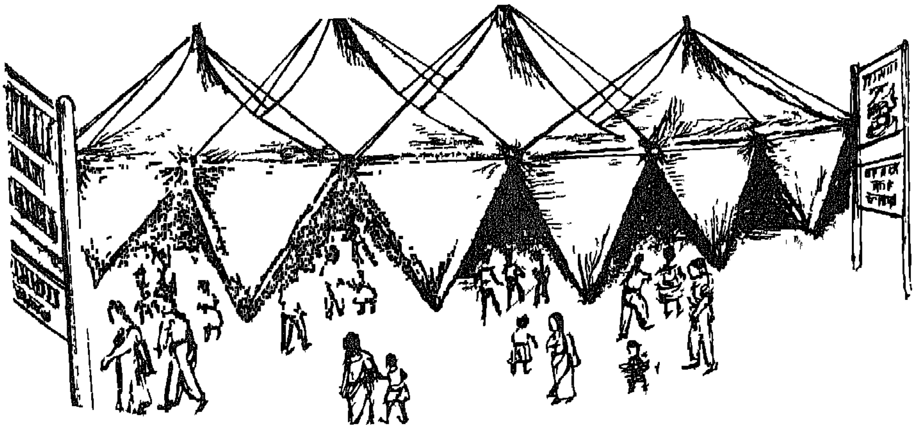

Fig 185 Discovery Dome

travelling exhibition and mobile exhibition. According to them, mobile exhibition is a unit which is equipped to carry on its activities within or around itself, wheres travelling exhibition is portable and its exhibits are displayed by spreading them out in an exhibition hall. In some countries a mobile unit is interpreted as one which moves on wheel in irrespective of whether the exhibits are displayed in it or taken to another building for display.

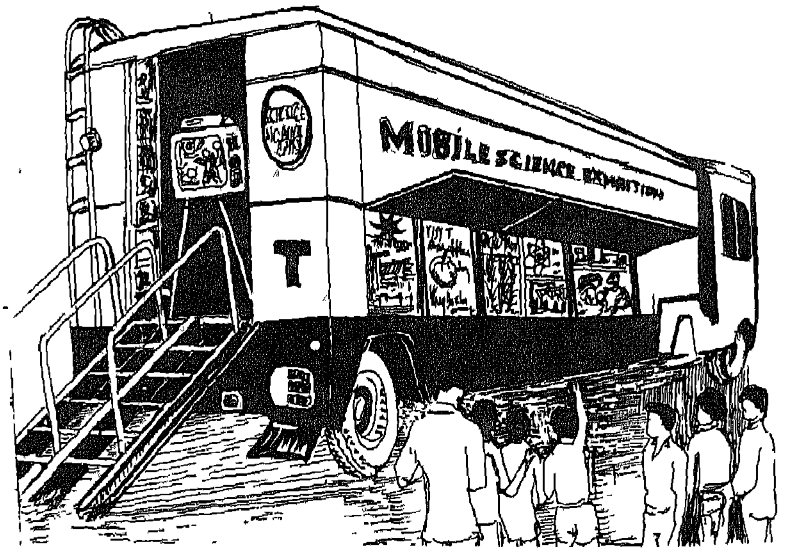

Fig 186 Museobus (Ref. 2)

Mobile exhibition is housed in a Museobus. This was fabricated in India for the first time by BITM and inaugurated on December 20, 1960. In USA, among others, mobile science exhibitions by the Science Museum-Virginia (Trans-Science I, 30 ft domed area for computerised A-V programme on satellites), Children's Museum in Nashville (primordial seas, mineral resources and fossils), Oak Ridge Associated Universities - ORAU (This Atomic World, 23 trucks), Lawrence Hall of Science-Berkeley (Discovery Van), Museum of Science and Industry-Chicago, Franklin Institute-Phildelphia, British Columbia provincial Museum (multi-media

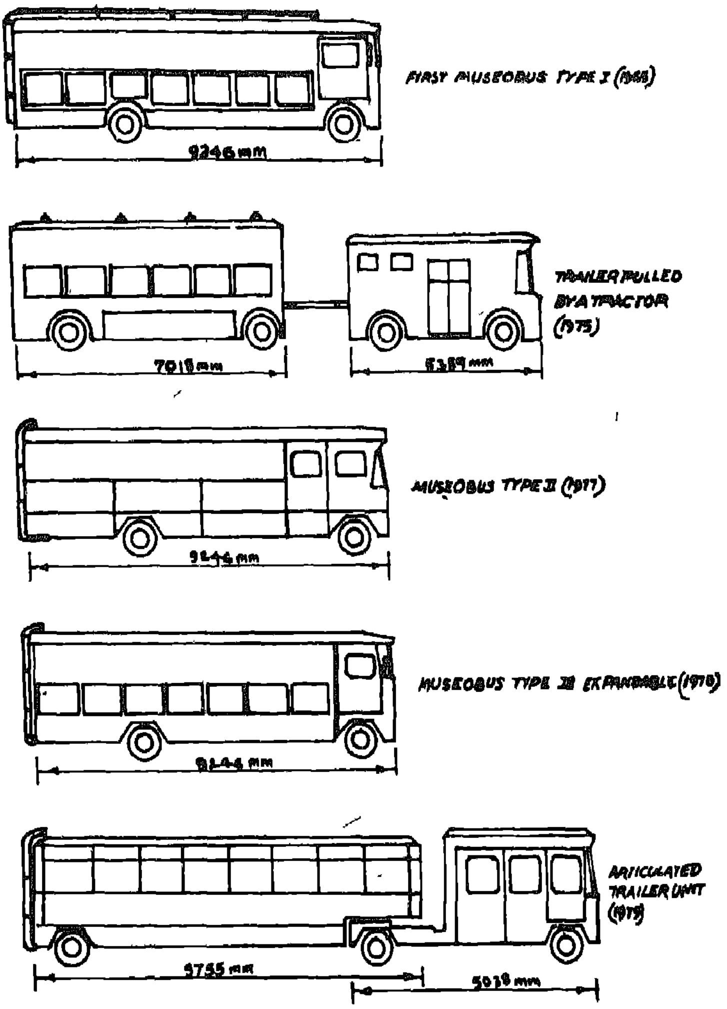
FIRST MUSEOBUS TYPE I
9246 mm
TRAILER PULLED BY A TRACTOR (1975)
7018 mm
5389 mm
MUSEOBUS TYPE II (1977)
9144 mm
MUSEOBUS TYPE III EXPANDABLE (1978)
9144 mm
ARTICULATED TRAILER UNIT (1979)
9755 mm
5038 mm

Fig 187 Development of Museobus and Trailer Units (Ref 2)

school kit-exhibits, marine biology), Michigan Department of state (History Mobile), South Carolina Arts Resources Transportation Service (ARTS, 45ft mobile studio containing dark-room, painting, film making, print making, pottery) are popular.

The 'present exhibition trailer and tractor' of various types is the result of continuous R &-D work in India in this area. The sequence of development has been shown in Fig 187 During 1989-90, thirteen mobile units of NCSM crisscrossed the length-and breadth of the country drawing 1.17 million visitors, the total distance covered was 23905 km (Ref 4)

New and Renewable Source of Energy 9 (NRSE)

(b) Mobile Exhibition Van for showing new and renewable energy sources (NRSE)

For the new technology to be acceptable to the common man, mass awareness has to be created. Publicity through mobile exhibition van has proved to be one of the effective media as it offers an opportunity for on the spot information and interaction. The working system and devices mounted on the van can demonstrate actual operation. Exhibition can be held at a very short notice particularly in village fairs, melas and institutions. Department of Non-Conventional Energy Sources (DNES) has such mobile exhibition vans at Delhi and Hyderabad. Nodal agencies in some states have also such vans.

5. Bal Bhavan Movement

The Bal Bhavan kendras foster creativity in children and give them the opportunity to work and learn by doing; facilities offered are briefly outlines below,

Creative Arts—Needle craft and stitchery, clay modelling painting, handicrafts, wood work, weaving, book binding.

Integrated Activity-- folk art, craft, chess, creative games, value based games,

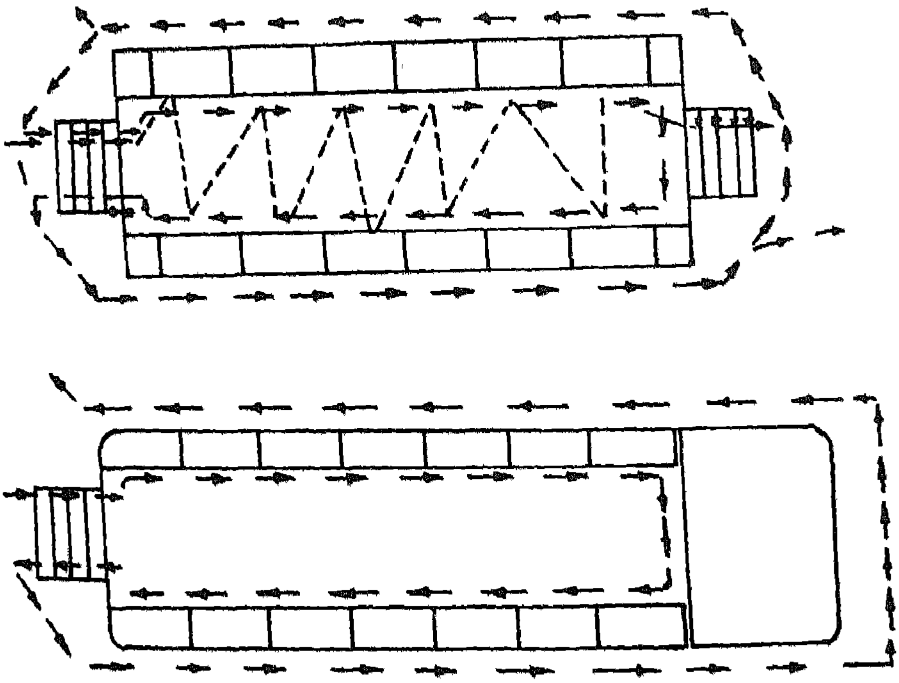

Fig. 188 (a) & (b) Circulation in Trailer and Museobus traditional folk painting, recreating new ideas.

Performing Arts-- Music, dance, drama, puppetry, percussion

Science Education-- Radio, electronics, aero modelling, machine modelling, how and why club.

Environment-- Awareness programmes, creative writing, poster making, tree plantation, environmental marches, film shows, lectures, visits, creativity fair.

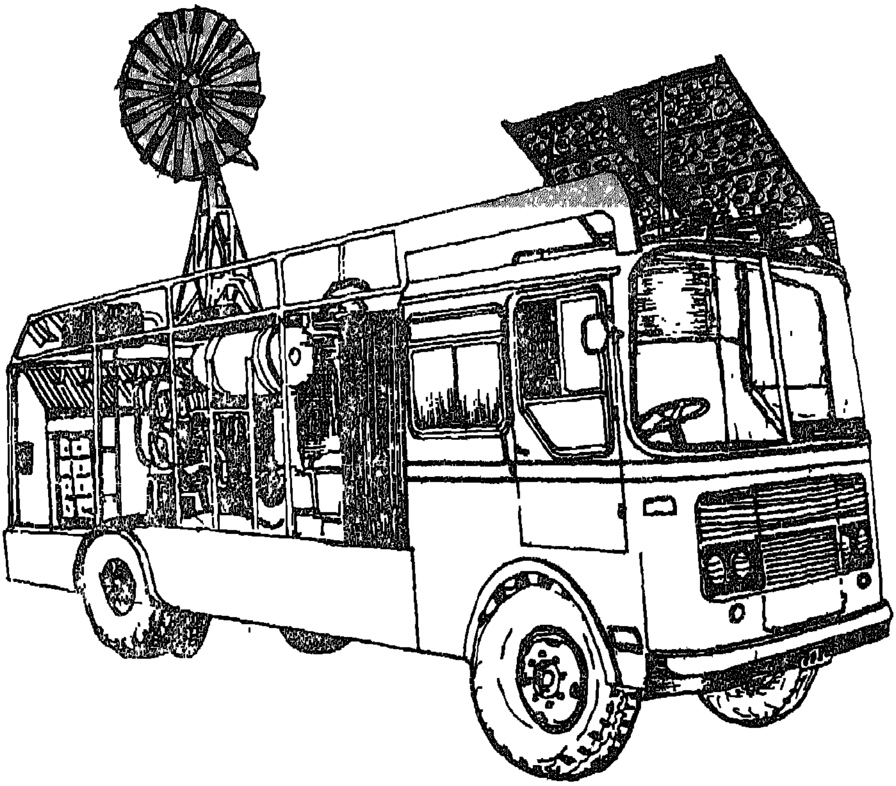

Fig 189 NRSE Exhibition Van (Ref 9)

Planetarium-- Low cost astronomical units, teacher training in astronomy, interaction of children with scientists.

There are support facilities/activities like library, national children museum, camping hostels, funny mirror, mini train etc Club activities like inventor's club, photo club, 21st century club computer club, mural/sculpture club etc are very attractive to school students.

You should contact the nearest centre and take part in the activities of your choice For detailed informations about Jawahar Bal Bhavan Mandi, rural Bal Bhavan Kendras, extension projects and other details you may write to Bal Bhavan Society. More than 2000 Bal Bhavan Kendras/district Bal Bhavan Kendras are working, all over India under the supervision of respective state Bal Bhavan and Jawahar Bal Bhavan. The distribution of Bal Bhavans are given below (Ref 8):-

Andhra Pradesh
Hyderabad
Secunderabad
All Districts
Bal Kendras in Mandals

Assam
Guwahati
Dibrugarh
Naiban
Pakighat

Arunachal Pradesh
Khosla Itanagar

Bihar
Gopalganj
Patna

Goa
Altinho
Panaji
Bal Bhavan Kendras

Gujarat
Ahmedabad
Amreli
Rajkot
Vadodara
18 Corpn Bal Kendras

Haryana
Gurgaon
Panipat
Jind
Hissar
Bhiwani
Ambala city
Rohtak

Jammu and Kashmir
Srinagar
Sopore
Jammu

Karnataka
Bangalore
Mysore and district
Bal Bhavans
Chick Mangular

Kerala
Trivandrum
Quilon
Kottayam
Cochin

Madhya Pradesh
Gwalior
Bhopal
Sidhi

Maharashtra
Pune
Bombay
Deopur Dhule
Kasal
Distt. Ratnagiri
Hingoli
Distt Parbha
Deulgaon Raja
Buldana and Bal Bhavan Kendras

Manipur
Awangkhul

Orissa
Bhubaneshwar

Punjab
Jalandhar
Hoshiarpur
Kotkapura

Tamilnadu
Madras
Madurai
Pudukkottai
Bal Bhavan Club-Egmore
Bal Bhavan Kendra
Shenoynagar

Uttar Pradesh
Allahabad
Lucknow
Kanpur
Mirzapur (NTPC)
Hardwar(BHEL)

West Bengal
Calcutta
Howarh
Burdwan
Bhirbhum
Bankura
24 Praganas,
Purulia
Hooghly
Midnapur
Nadia
Chandigarh
Dadra Nagar Haveli
Pondicherry
J B B Mandi (Delhi)

6. Science March, Science through Mass Media, Street Play etc.

6 1 National Science Day

Popularisation of science through Science March, Street Play etc are being increasingly popular these days In 1987 at NCSTC's initiative, the Govt of India decided to observe 28 February as the National Science Day On this day in 1928 Prof C V Raman announced 'Raman Effect.' He was awarded Nobel prize, the first in Science in Asia Science March is held in many places on the same day by thousands with banners, festoons and posters carrying messages of science. They also sing songs and perform street plays on various aspects of science. NCSTC also announces winners of its national awards in science popularisation on that day.

6.2 Bharat Jan Vigyan Jatha (Ref. 7)

A unique event was catalysed and supported by the NCSTC (National Council for Science and Technology Communication), Department of Science and Technology, Govt. of India in 1987. 26 PSM (People's Science Movement) groups from all over the country and NCSTC jointly organised Bharat Jan Vigyan Jatha. The 26 voluntary organisations constituted a National Organising Committee(NOC). List of the organisations is given in Appendix - VI. The march originated simultaneously from different towns--Madras, Sholapur, Imphal, Malda (on October 2) and Srinagar (on October 3, 1987). The Jatha covered a total distance of 25000 km halting at 500 places enroute to Bhopal The march ended on November 7, 1987 at Bhopal.

The Jatha spreaded the message of self-reliance, national integration, people's science movement on their way. Exhibitions, slide shows, popular lectures, film shows, script plays, science and technology toys/models/kits, acro-modelling, sky watching, quiz contest competitions, songs, dramas were organised by over 500 local committees dotted over the country before and during the march. A list of communication materials is given in Appendix - VII 7-8 million people were covered directly by the march, many times more indirectly through mass media. The event was extensively covered by All India Radio, Doordarshan, UGC's Educational Media Research Centres, CIET of NCERT and Films Division. Through this event 500 different groups in the country who are eager and interested in taking the message of science to the people were identified. The second Bharat Jan Vigyan Jatha is proposed to be held in 1992 between October 2 and November 7 at 50,000 locations dotted all over the map of India.

NCSTC, jointly with AIR, produces radio programmes as well: a 13-part radio serial on the method of science titled *vigyan vidhi* was broadcast by almost all AIR stations in 17 languages on Sunday mornings during June- September, 1989. A 104-part serial on the story of human evolution has been introduced in the AIR broadcast from June 1991.

NCSTC also supports[10] different organisations on activities like telescope-making workshop, writer's workshop, essay, painting and poster competition etc. You may set up a Ham club station in your science club; NCSTC's instructions for this are reproduced in Appendix-VIII. NCSTC software is listed in Appendix-VII.

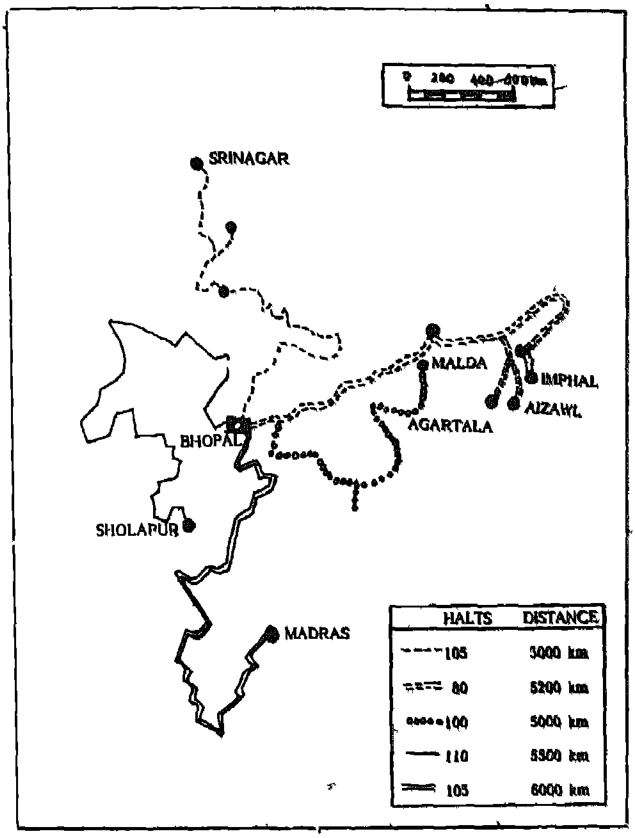

FIG. 190 (Ref. 7)

Look at the map (Fig.190) which shows 5 different routes of 5 zonal Jathas. These ultimately met at Bhopal on November 7,1987.

(a) Plot the locations of Jantar Mantar Observatories museums, science centres, planetaria, aquaria, Bal Bhavan kendras, zoo gardens, science parks, energy parks, state science & technology councils, NOC member organisations (Appendix - VI) and similar such centres on the same map

(b) Draw the outline map of your State/UT On it plot districtwise all such organisations and different local centres engaged in popularisation of science. This will help you and your school to decide how you can benefit from the exhibition/programmes offered by them.

6.3 Science Magazines

There are many science magazines which are well illustrated and written for readers like you. The following are some of the popular science magazines and their publishers.

— *Science Reporter* (English)	CSIR
— *Vigan Pragati* (Hindi)	CSIR
— *Science Ki Duniya* (Urdu)	CSIR
— *Popular Science and Technology* (English)—DESIDOC	
— *Science Today* (English)—Times of India Group, Bombay	
— *Jago aur Jagao* (Hindi)—Adult Education Association	
— *Chakmak (Hindi)—Ekalavya, E-1/208 Arera colony, Bhopal 462016*	
— *(Supported by NCSTC)*	
— *Kheti* (Hindi)	SCAR
— *Phal-Phool* (Hindi)	ICAR
— *Krishi Chayanika* (Hindi)	SCAR
— *School Science* (English)—NCERT	

India News Agencies run *Science News Services*. Indian Newspapers these days highlight developments in science and technology in simple language. Some dailies print interesting supplements on science and technology news on a particular day of the week.

You should listen to talks, discussions by scientists, science quiz and interviews on science and technology events on the All India Radio. You might have already enjoyed some programmes on science and technology telecast by Doordarshan e.g. Krishi Darshan, Jaan hai Jahan hai, science and technology institutions of India, programmes on energy and wild life, Quest (science Quiz), UGC programmes etc.

6.4 Street plays

Science popularisation movement through street plays started by the Kerala Sastra Sahitya Parishath (KSSP) during the last decade has been well received everywhere. There are 8- 10 performers who are usually without any special make-up. Sound from a drum and a pair of manjira creates a festive atmosphere and attracts everybody around. Wherever necessary, these also provide supportive rhythm to dialogues and songs. In one of the plays, the message that the sense of rhythm and music in the man came from the sound of his own heart beat was to be conveyed to the audience; the drum played a very significant role here when it first produced the sound of heart beat and went on to produce the rhythm of a typical tribal dance. The songs of such street plays touch everybody in the audience. The duration of one play is nearly twenty minutes on the average. Songs and dialogues of some of the street plays of KSSP e.g. OH! Universe, E = MC^2, The Atom, The Universal Man, Come Along - Everybody, The Earth—are reproduced here. Besides KSSP there are various other organisations which are also doing excellent work in this direction.

OH : UNIVERSE

Oh Universe, are you mere mere maya
What are you! solid, liquid or gas
Or plasma or mere energy?
Or darkness or light?
Or heat or cold?

Are you the atoms in the molecule?
Or the particles in the atom?
Or the motion of the particles?
Or the energy of motion?
Or the particles of energy?
Or the waves of particles?
What are you; oh universe?

Are you the product of time?
Or the manifestation of space?
Or 'your own nature'?
Or matter profound?

Is your name maya?
Oh universe what are you?
Darkness or light?
Heat or cold,

Where are you? difficult to locate
Where do you go? difficult to determine
Is your name uncertainty? difficult to define

Who created you?
And the creator of that creator?
What is your beginning? What is your end?
Are you unknowable? and unrealisable?
Are you nothingness, pure nothingness?

Oh! fool of a man, open thine eyes
I am the fire of they stomach
I am the passion of thy nerves
I am the desire of thy mind
I am the pain of thy body
I am thy stomach, nerves, mind and body
I am everything and everywhere

Thou art only a part of me
Thy brain, nothing but my motion
I am beingless and endless
Matter is what I am
In forms multifarious
As space, time and everything

Oh man, thou art my best manifestation
Don't close thy eyes and make darkness around
Oh man, interact with me, know me and be liberated!

$E = MC^2$

Twinkle, twinkle little star
How I wonder what you are
Up above the earth so high
Like a diamond in the sky

Twinkle, twinkle little star
How I wonder what you are?
I will tell you my secret
Lend me your ears, oh dear child
My belly is of plasma form
And it is full of protons proud

Under pressures inconceivable
And temperatures unimaginable
Four by four do they combine
Forming alpha particles

And lo! behol some matter disappeared
Where is it gone? Where is it gone?
A scientist named Einstein-
Gave this answer long ago :
E equals M C squared.
That is the secret of my twinkle.

Up above the earth so high
Like a diamond in the sky
Twinkle, twinkle little star
Now I know your secret well.

THE ATOM

Atom! Atom!
Oh ! your ego
Are you the base of
All things moving and static?
At first we thought you
Are indivisible.
Then came Thomson and Rutherford
They stole all your secrets away.
They said you are
Electrons, protons and neutrons
However minute you be
How active you are!
The mad rush of electrons
The quantum jump.
The movement in your centre
The defection of protons
The treachery of neutrons...

The exhange of mesons
A veritable market place
The moment we blow you up
You emanate enormous energy
For creation, protection and destruction!
Using thy mighty power
Man makes Hiroshima
Man makes empires......

THE UNIVERSAL MAN

[Look, look at that man, that Universal Man, both his legs fixed firmly on the soil—the symbol of toil—with a book—the symbol of knowledge—in one hand, pointing another hand into the interiors of the atom and the infinite sky, connecting practice with theory and the past with the future]

[The singer in the middle; eight people sit in a circle]

Singer : Man, Universal Man
Man, who has grown high as sky
Man, Universal Man
Man

[The group slowly rises up and, raising their hands]

Group · Universal Man, man who has grown high as sky

[The singer moves out and another man moves to the centre]

Singer : Fixing his legs on
The mother earth
Food-giving earth-

[The person in the centre sits down]

In to the interior of atom
Onto the infinite sky
Goes the man,
Universal Man,
In search of knowledge

[The group holds hands parallel to the earth, to the inside. As the man in the centre rises, raising his hands, others slowly sit down- while singing "into the interior of atom..."]

Singer : Man
Group : The Universal Man

....
....

[As they join to sing "The Universal Man", the group members, raising both hands, forms a corner-to-corner line on the stage, just as the song is repeated for the second time]

Singer· With the hands that held the tools,
With communal life
Group · With the magic of speech
Singer Man evolved from the ape

[The group members, jointly and singly engages in different forms of work. When the singer sings "man evolved", the beat stops. Freeze. The singer repeats]

Singer · Man evolved.........
Man... ....
Group. Universal Man... ..

....

[When the group begins to sing 'Universal Man' the corner-to-corner line breaks in the middle Each section moves forward in opposite direction to form two circles]

Singer: Split into
Different castes
Different classes
And fought.......
Still unperished
Endearing by
The greatness of labour
United stands the man
The Universal Man

[While the song continues, each section of circles engages in different forms of work. At the end of the line, "united stands the man" freeze]

Singer: Man
Group. The Universal Man.....
....

[While singing "the universal man" three persons each stand on either side of the singer. The girl and another member withdraw. Those who stand on the right side look to the right and those who stand on the leftward and rise a hand spreading it and the other hand close to the chest-Freeze]

Singer: Fixed firmly on the soil
Embracing the sky
At the crossroads of infinities
Connecting
The past with the future
Practice with theory
There stands the determined
Man, the Universal Man.......

[The group join hands and continue to sing "the universal man... .....". While the lines given below are being sung, a youth carrying a flag with the Parishad emblem follows a girl carrying a placard with a big emblem drawn neatly, stepping out from behind the singer]

COME ALONG, EVERYBODY

To propitiate the Goddess so that she may be kind to us
Let ye all come, to play and to please the goddess.
Let ye all come to play to the beats of the drum
Let ye all come to play to rhythm of bells.
(dance steps)
To smear on the arena let us collect some cowdung
To collect the cowdung let us make the basket
To make the basket let us get the reeds

To get the reeds let us go to the Eastern Mountains
To the eastern mountains where the sun gets born
We go to the mountains, we search one after another
And all of them are as bald as grandfather's head.
(dance)
We go to the fields to collect some dung
We search field after field and we find none.
It smells of blood, their intestines
Ulcerated through and through.
(dance)
To offer to the goddess, we go in search of wild pigs,
We go hunting, hunting pigs.
But, there is no forest on pig
Not even a guinea-pig.
(dance)
The riverain fish, with shredded coconut,
Green chillies ground together
Packed in banana leaf,
Baked in the kitchen fire
There is nothing which pleases the goddess more
To please the goddess we go to the river
We dive into pool after pool
We search hole after hole
There is no trace of
Even a species named fish
(dance)
To lighten the spirit of the goddess
We climp the coconut palm.
We hit and hit, hit and hit, but
Not a drop of toddy
Comes out of its body.
(dance)
The forests of the goddess are gone
Her water has become poison
There is nothing to propitiate her with
This is the work of some greedy lords
To make some quick money thereof
It is no longer time to play
It is time to act firm and stern
For that come along, everybody,
COME ALONG EVERYBODY

THE EARTH

For ages in our mind
Lives this earth, so fine
Which we did borrow from the future
Which we have to give back, for sure.

This is not an inheritance infinite
For a prodigal son to squander unlimited

Here on this soil, on the banks of rivers
With mountains high and plains broad
From time immemorial stood the trees
With sprouts and flowers, spreading shades so cool
Giving out warm beauty of hearts
Singing softly- Men slept in her laps
Generations grew up under her care.

When thunder and lighting
Rent their hearts with fear
She became their protector
Giving them motherly care.

Her rivers overflowing with affection
Gave water sweet to quench their thirst
When their stomach burnt with hunger
She gave grains in fields, fruits on trees.

The sun oozing blood, the rising moon
Make their evenings beautiful
The moon shining itself out
Gives their night a milky light.

Where are those trees
And their tender milk
—Under the teeth of roaring saws
Their leaves fallen
Filling pockets far away

Where are those rivers
Flowing from the bosom of earth
Water made dirty with worms and poison-
New wealth, new millionaires

Beware! you listen
Listen, you listen.
This earth which makes us what we are
This earth is not a family property
Inherited from generations bygone
We borrowed from children
And we have got to give it back.

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VI

How to Arrange a Proper Display in a Temporary Science Exhibition

This chapter exposes you to the typical situation in a temporary exhibition pavilion After going through this chapter you will be able to:
—calculate display parameters for better viewing
—estimate visitor-traffic flow and prepare yourself accordingly.

M

1. Temporary Exhibition Structure and Furniture

Temporay exhibition structure could be anything between an improvised umbrella and a modem foldable dome with sophisticated materials. A typical temporary structure which is the most cost effective today and used widely is shown in Fig.174 The cheapest version uses bamboo poles and common tent house materials. In some regions units of *kanat* are used to cover the sides while in others corrugated tin sheets are used. Sometimes steel pipe structures are used in place of bamboo poles.,

The table which constitutes the main piece of furniture in such an exhibition is generally of the size of 150 cm × 90 cm × 75 cm (5ft × 3ft × 2ft) with foldable legs The ordinary foldable chair has a seat height of 35 cm (14"0 Foldable *kanat* is 1 83 m (6 ft) high The ceiling of the *shamiana* is generally 3 05 m (10 ft) high. The choice of the organiser is generally restricted to the selection of undamaged and newer pieces of furniture and other such materials from one of the local tent houses

In the temporary pavilion there is always leakage of daylight through the gap between the top of the *kanat* and *shamiana* This has to be stopped by thick cloth Otherwise the visitor will have glare. The multi-coloured *kanat* also offers visually disturbing background. Morever the display suffers a serious setback when drawing sheets containing captions and graphics are pinned to the *kanat* (the participant has no other facility for exhibiting on a vertical plane). The drawing sheet mostly falls off after sometimes These factors disturb the participants and visitors. some feasible modifications could be.

Materials required for one Display Unit

Part name	*Materials/ dimensions*	*No off*	*Remarks*
(a) Stand with cross base	M.S, pipe 25 sq ,16 Swg, height 2134.	1	painted blue.
(b) Pipe (smaller)	Length 19,16 Swg	1	painted blue
(c) Table Top	Commercial blockboard 1219 x 610 x 19 thick with sunmica	1	white
(d) Front Cover	Commercial plywood 1219 x 381 x 12 thick	1	painted blue
(e) Vertical Face	Teakwood, 1219 x 57 x 32 thick with sunmica	1	white
(f) Curtain Pipe	M.S 19 dia x 1194 long	1	painted blue
(g) Pelmet Hook	M.S. 19 x 19 x 3 thick	2	painted blue
(h) Hook	MS, 76 x25 x 3 thick	2	painted blue
(i) Hinge	MS, 76 x 25	6	plated
(j) Bracket	MS pipe as at (a) and (b)	2	painted blue
(k) Pelmet	wood 1219 x 178 x 19 thick	1	painted white
(l) Legs	MS pipe as at (a)	2	painted blue
(m) Display Board	1219 x 1219	1	as per requirement.

all dimensions are in mm.

(a) The multi-coloured *kanat* is covered by stiff opaque sheets (off-white colour) of suitable material (e.g. plyboard, hard board or plastics). The drawing sheet with captions etc. can now be pasted or tacked on these boards in a befitting manner.

(b) As an alternative to the stiff boards, portable vertical bulletin boards or any one of the display units shown in Figs.158-164 may be used.

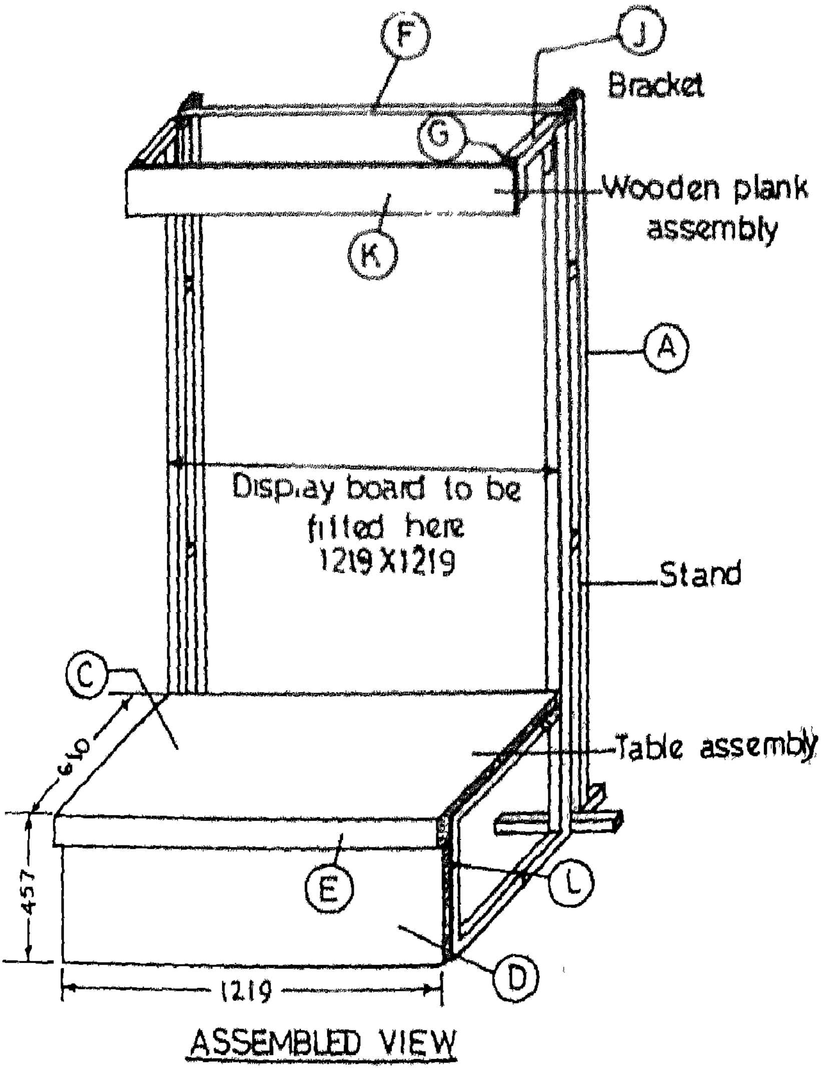

FIG. 191 (a) Display Unit.

(c) Special display board designed in Workshop Deparyment, NCERT as in Fig.191 may also be used. In this case, no extra table will be necessary as the display unit itself offers both horizontal and vertical surfaces for three dimensional exhibits and written words respectively. Such units may be joined in series to form U,L, Z,T,I or any other form depending upon the available exhibition space and desired flow of visitor-traffic. These units are foldable and stackable. These are light and

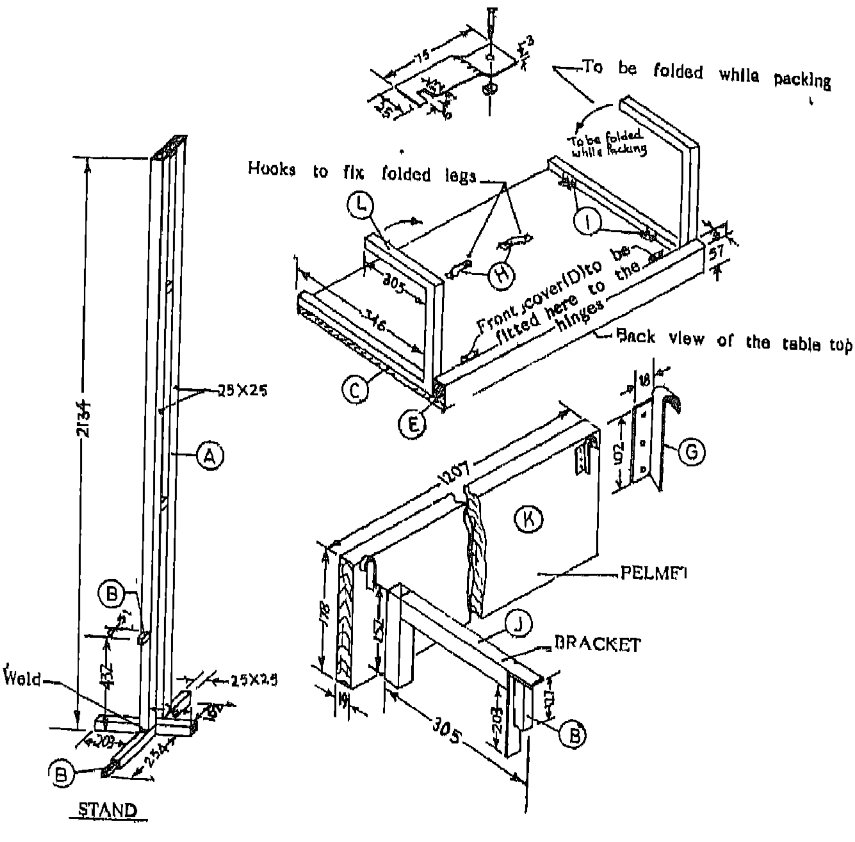
75
3
35
To be folded while packing
To be folded while packing
Hooks to fix folded legs
L
I
H
305
346
Front cover (D) to be fitted here to the hinges
Back view of the table top
57
C
E
2134
25X25
A
18
102
G
1207
K
PELMET
J
BRACKET
178
19
305
203
B
B
432
Weld
25X25
203
254
B
STAND

FIG. 191 (b)

portable so as to be easily laid out or dismantled by two persons very quickly.

(d) A table topper (Fig.192) can also be used in conjuction with ordinary tables. This table-topper is portable and has three types of display boards i.e perforated board, cork sheet, magnetic board of 92cm×61 cm (3ft×2ft) size. In addition it has also a roll-up rexin sheet which can be used as a chalkboard. This table topper also offers scope for storing nearly 10 drawing sheets and many art materials like pencils, pens, chalksticks, colours etc. This prototype has been designed and tried out by the Workshop Department, NCERT.

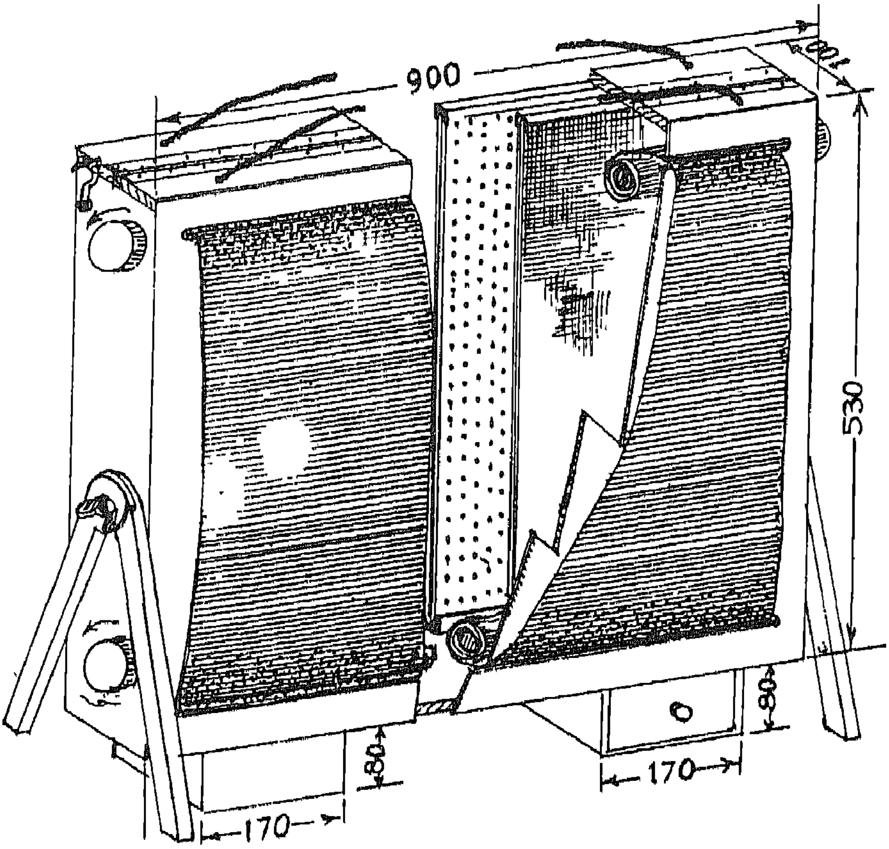

FIG. 192 Cut view of table topper

See Figs 188(a) and 188(b) which are showing the passages for circulation in the museobus and trailer.

Can you suggest.-

—how many persons can see the exhibits at one time inside the vehicle in each of the two cases?

—if each person takes nearly 2 minutes at each exhibit,(a) how much time does he take to see all exhibits? (b) What will be the flow of the visitor-traffic in terms of number of persons per hour during peak hours? Note that there are exhibits both inside and outside the vehicle.

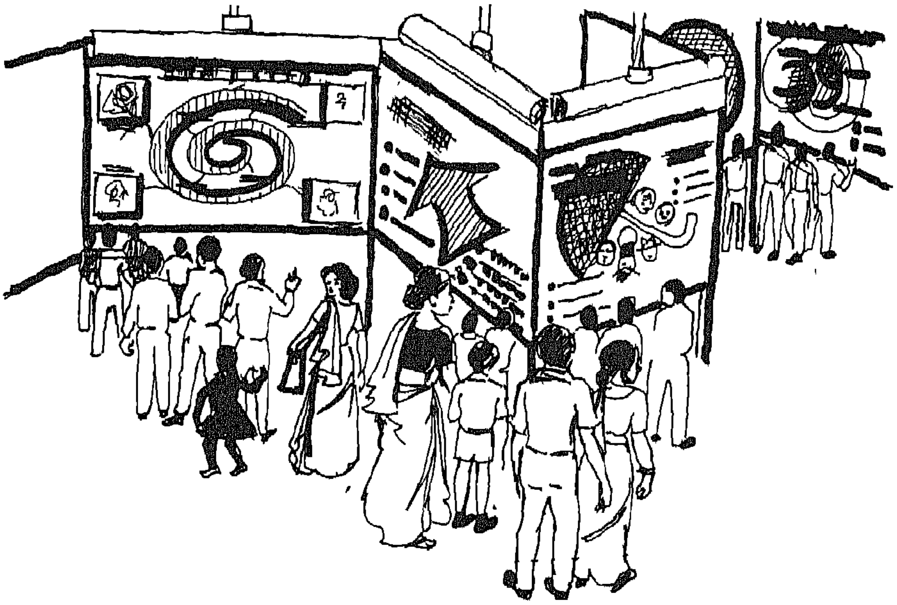

FIG 193 Graphics Display

M

2. Human comfort, placement of exhibits on horizontal and vertical surfaces, display proportions

Our perceptor sensory mechanisms i.e eyes, ears, nerve endings etc are sensitive to atmospheric pressure, heat, odour, taste, sound level, humidity and dust in the air and host of other factors. These are constantly in contact with the immediate environment These senses provide stimuli for our perceptual reorganisation and reintegration So if one or more factors of environment around any person have values beyond the limits of human tolerance, disturbance or lack of concentration in his mind is created which has adverse bearing on perception The exhibition hall or ground which is generally crowded may have adverse environment It is upto the organisers to take care of each and every point at the planning stage. The starting point for site planning should be the number of visitors per unit time and control of the visitor-traffic flow While planning display, you must consider viewer's eye level, angle of vision, distance from the exhibit, lighting arrangement, space for movement etc Considering that the height of an average person is approximately 160cm, display of graphic should be made on a vertical plane between 130 cm (may be even less) to 200

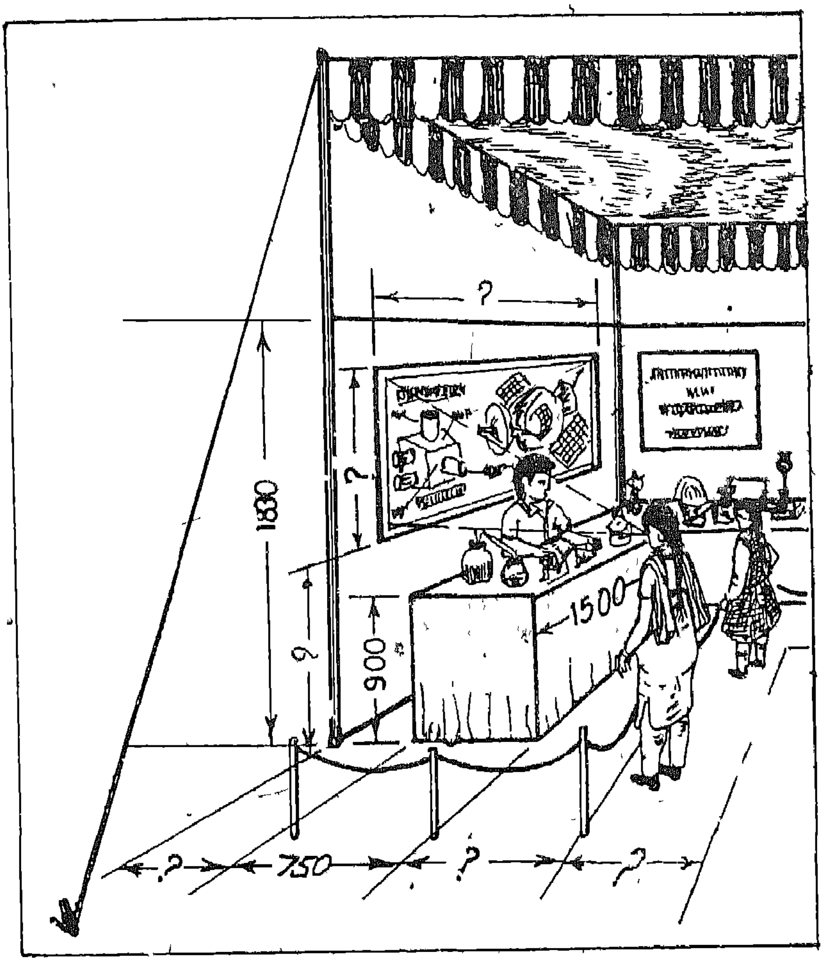

FIG 194 Display of models supported by graphics and oral explanation

cm (may be slightly more) from the ground Exhibit area on the vertical plane should be generally 2m x 1m Human eye can scan an area of nearly 4 sq. metres from a distance of 3 metres with very little movement of the eye ball.

Display techniques have been discussed in details in Chapter IV Communication is a two-way sharing process that makes an idea common to two or more persons It involves much beyond written and oral words but encompasses all possible materials and procedures by which one mind may affect another The range of communication is from face-to-face to mass Each of us is curious about something, satisfaction of curiosity should be made enjoyable. So one, who has thought out a good science model and has subsequently succeeded in giving shape to his/her ideas meaningfully and now wants to communicate these to others will have to keep human comfort and display parameters in mind and make judicious use of verbal and non-verbal communication For a successful display

— design the graphics which can convey the message in 5-10 seconds
— 'avoid unnecessary decorations or 'scattershot' get up as these misguide viewers
— exercise economy in oral words.
— distribute hand-outs if you feel that graphics and oral words are inadequate to describe your exhibit

Suppose you have planned your pavilion as shown in Fig 194 Taking clue from your calculations on the exercise given in Figs.188(a) 188(b) can you suggest the various dimensions missing in Fig 194 ? Assume that there will be 5000 visitors per day of seven exhibition-hours and each visitor will stop at your stall for 2 minutes on the average.

Appendix-I

LIST OF EXHIBITS CATEGORISED AS "IA" DURING 1985-90

Sr No	*Name of the model*	*Year*
1	Land Level Indicator	85
2	Manufacture of Chalk	85
3	Hydraulic Pump	85
4	Magnetic Levitation Train	85
5	Door Alarm	85
6	Ditto Machine	85
7.	Conveyor with Counter	85
8	Indigenous Paint Sprayer	85
9	Solar Water Heater	85
10	Universal Level Meter	85
11	Electronic Bongo	85
12.	L.E.D. Temperature Indicator	85
13.	Air Pollution Control Device	85
14	Electronic Combination Lock	85
15	Strain Indicator	85
16.	Automatic Candle Lighter	85
17	Blind Man's Balance	85
18	Speaking Aid for the Dump	85
19.	Lighter for the Handicapped	85
20.	Helping the Helpless	85
21.	Balance for the Blind	85
22.	Electronic Cardophone	85
23	Auomatic Tea Time Caller	85
24.	LPG Consumption Measuring	85
25	Air Expansion	85
26	White Slate Projector	85
27.	Structural Wonder of Genetics	85
28	The determination of "G"	85
29.	Surface Tension Balance	85
30	Intercommunication Set	86
31	Electrical Locking System	86
32	Bati Cooker	86

33. Saving of Energy and Work 86
34. Six-In-One 86
35. Wind Operated Scare Crow 86
36. Automatic Flame Controller 86
37. Air Bell 86
38. Hand-Operated Water Pump 86
39. Pedal Operated Water Pump 86
40. Efficient Oven 86
41. Low Cost Energy Saving Burner 86
42. Utilisation of Solar Energy 86
43 Multifuel Oven 86
44. Air Pressure Call Bell 86
45. Candle Control 86
46. Energy from Tides 86
47. Alarm Time Tea Maker 86
48. Auto-Helio-Centric Solar Heater 86
49. Low Impedance Aerial 86
50 Sea Water Distillation Plant 86
51 Solid State Automatic Light 86
52 Wallclock Operated by Gobar Cell 86
53 Automatic Controller of Tube A Well 86
54 Production of Hydrogen from Ocean 86
55. Mini Computer 86
56. Water from a See-Saw 86
57. Detection of Nicotine 86
58. Instrument to Form Good Habits 86
59. Electronic Mother 86
60. Eye Defect (a working model) 86
61. Hydraulic Robot 86
62 Moisture Meter 86
63. Ion-Detector 86
64. Load Carrying Property of Sand 86
65. Multi-Tester 86
66. Pot Sound Box 86
67. Home and Aesthetics 86
68 Modern Potter's Wheel 86
69 Water Lens Telescope 86
70. Directional Microscope 86
71 Mini Robot 86
72. Rural Rheostat 86
73. Charm 86
74. Science and Magic 86

75	Magic Neck	86
76.	Flower Dropping Machine	86
77.	Solar Heater	87
78	Flood Alarm Safety Measure	87
79	Panchachakra	87
80	Ghareloo Pressure Cooker	87
81	Soil Moisture Checker	87
82.	Energy from Bio-Gas	87
83	Prevention of Air Pollution	87
84	Automatic Humidity Control	87
85	Bio-Electricity	87
86	Production of Electricity from Cow Dung	87
87.	Automatic Water Supply	87
88	Low Cost Insecticide Sprayer	87
89	Automatic Water Tap	87
90.	Treatment by Vibrations	87
91	Automatic Dipper	87
92	Gravity Transport	87
93	Indication of Danger on Bridges	87
94	Traffic Controller	87
95.	Electronic Breathalyser	87
96	Transport and Communication	87
97	Floating Space Station	87
98	Tubewell with Bamboo Accessories	87
99.	Cooking Gas Leakage Alarm	87
100.	Spinning Coil	87
101.	Electricity from Leaf	87
102	Photo Connections	87
103	Low cost Emergency Light	87
104	Automatic Switch for Electric Motor	87
105.	Compound Tareng	87
106.	Indigenous Method of Printing Technology	87
107.	Rust Cell	87
108.	LPG Level Indicator	87
109	Load Checking System	87
110.	Mind Reader	87
111.	Remote Control Boat	87
112.	Magnetic Cricket	87
113.	Paise Ka Magic	87
114	Electronic Harmonium	87
115.	Cordless Musical Telegraph	87
116.	Electronic Magic Bell	87

117 Handmade Camera 87
118. Fountain of Fire Experiment 87
119 Stereo Deck Amplifier 87
120. Working Model of Reflecting Telescope 87
121. Demonstration of Curie Temperature 87
122 Modulated Waves 87
123. Weight Measuring Balance 87
124 Improvised Meter Bridge 87
125 Modern Mathematical Instrument 87
126 Wave Motion 87
127 Kymograph and the Heart 87
128. Hydraulic Press 87
129 Novelty 88
130 Improvised Hope Apparatus 88
131. Water Gas Stove 88
132 Remote Measurement of Flow of Water 88
133. Air Pressure Fountain 88
134. Water Stove 88
135 Protection Against Sudden Rain 88
136. Automatic Mortar, Pestle and Alarm 88
137. Water Pump 88
138. Selfstart Distribution Water Plant 88
139. Double Efficient Water Pump 88
140 Water Electic Regulator 88
141. Automatic Pully 88
142 Canal Generator 88
143 Automatic Rain Gauge Time Indicator 88
144 Automatic Electronic Water Level Indicator 88
145. Automatic Water Distribution Plant 88
146 Solar Water Lifting 88
147 Non-Wastage Public Supply Device 88
148. Water Level Indicator/Auto Light System 88
149 Prevention of Water Wastage from Over Head Tanks 88
150 Food Indicator Device 88
151. Modern Hand Pump 88
152. Automatic Hygienic Water Tap 88
153. Rain Drop Alarm 88
154. Floating Turbo Generator 88
155. Electricity from Waves 88
156 Marine Instrumentation in Ocean 88
157. Innovative Measures for Extraction of Metal 88
158. Recycling of Waste Water 88

159	Valveless Filtration Plant	88
160	Automatic Water Head Controller	88
161	Ripple Tank	88
162	Water Telescope	88
163	Saline Aqua Desalting	88
164.	Wter Cycle in Nature	88
165	Water Microscope	88
166	Bellow Working by Water Current	88
167	Water Clock	88
168	Hydraulic Cum Pressure Machine	88
169	Vacuum Water Lifting Machine	88
170	Mechanical Simple Water Lifter	88
171	Operation of Lift by Water	88
172.	Jal Chalit Crane	88
173	Uses of Hydroenergy	88
174	Pipe Turbo Generator	88
175	Solid State Auto Control Water	88
176	Electricity form Potatoes	88
177	Booster/Computer by Biobattery	88
178.	Hydraulic Weighing Machine	88
179	Improvised Air Cooler	88
180	Satellite Communication	85
181	Salyut-7	85
182.	Teaching Apparatus	85
183	Principle of Set-Theory	85
184.	Multiangle Finder	85
185.	Star Finder	85
186	Improvised Teaching Aids	85
187.	Design Board for Set Theory	85
188	Fossils	85
189	Shapes of Molecules and Crystals	85
190	Path of a Projectile	85
191	Test of Various Fibres	86
192.	Testing Various Food Materials	86
193.	Simplicity in Weighing	86
194	URO- Electronic and Medical Machine Kit	86
195	Fire Proof House	86
196	Superstitions	86
197.	Science and Superstitions	86
198	Scientific Magic	86
199	SHIVA Mandir	86
200	Eradication of Superstition	86

201 Tantra Puri 86
202. Science and magic 86
203. Science and Superstitions 86
204. Experiments Based on Science 86
205. Nature and Durability of Fibres 87
206. Fire Proof Construction Materials 87
207. Testing of Fibres 87
208 Vigyangi Longnik(sieve) 87
209. Earthquake Proof Buildings 87
210 Soil Solarization 87
211. Help to the Crippled 87
212. Writing Board for the Handicapped 87
213. Aids for the Handicapped 87
214. Safety at No Cost 87
215 Clap-Switch 87
216. Satellite Communication 87
217 Electonics Aeroplane 87
218 Centralised Train Control System 87
219. Simple Computer 87
220 Robotoid 87
221. Combat of Dust Pollution 87
222 A St Line Moves in a Curved Path 87
223. Maths Made Easy 87
224. Candle Control 87
225. Apparatus for Newton's Laws 87
226. Educational Instrument 87
227. Blood Circulation 87
228. Magnetic Balance 87
229. Bal Ganak Yantra 87
230. Test Computer 87
231 Digitogram 87
232. Modified Double Century Calender 87
233. Multiplication Aid 87
234 Jerk Proof Writing System 87
235. Tailor's Technique 87
236. Educational Aids 87
237 Sea Colour 88
238. Unique Properties of Water 88
239. Artificial Rain 88
240. Measurement of Percentage of Water 88
241 Vital Bond and Unusual Dipole Movement of Water 88
242. Bernoulli's Theorem 88

243	Utilisation of Roof/Rain Water	88
244	Water Purifier	88
245	Cleano Irro-Drinko Capacitor	88
246	Bamboo Water Filter	88
247	Rapid Gravity Filtration Plant	88
248	Innovative Technique of Treatment	88
249	Water Purification	88
250	Simple Method for Purification	88
251	Purification of Water from River	
252	Moleculer Movement in Paint Drops of Water	88
253	Flame by Water	88
254	Various Uses, Properties of Water	88
255	Multipurpose Steam Hearth	88
256	Water Dimmer	88
257	Lowcost Slide Projector	88
258	Holocausts by Star Wars	87
259	Teaching Aids	87
260	Accupressure	85
261	Landmarks of Science	89
262	Early Computing Machine	89
263	Digital Clock	89
264	Gyroscope	89
265	Rocket Launcher	89
266	Multipurpose Oven	89
267	Voltage Stabiliser	89
268	Jagriti Wind Mill	89
269	Electrical Energy from Wind Power	89
270	Bio-EMF Devices	89
271	Atmospheric Dust Catcher	89
272	Load Bearing Capacity of Sand	89
273	Computerised Weatherman	89
274	Detergent and Photosynthesis	89
275	Electronic Stick for Blinds	89
276	Electronic Cardiogram	89
277	Hydromicroscope	89
278	Test Your Heart	89
279	Silent Signalling	89
280	SLV-3	89
281	Easy Shunting Device	89
282	Jib Crane	89

283	Count Down	89
284	Working Model of Crane	89
285	Communication	89
286	Robot	89
287	Principle of Railway Track	89
288.	Sound Sensitive Photography	89
289.	Antrajyoti	89
290	Science in Magic	89
291	Voice Scrambler	89
292.	A waiting the Order,Sir	89
293	Photo Tracker	89
294	Science and Entertainment	89
295	Electronic Fountain	89
296	Mathematical Garden	89
297	Auto Protector of Bank Robbery	89
298	Optoelectronics	89
299	Musical Bell, Automatic Light	89
300	Science and Entertainment	89
301	Sincere Coin	89
302	OPD 2 Robot	89
303	Overhead Projector	89
304	Astronomical Telescope	89
305	Mathematical and Scientific Instruments	89
306	Computers	89
307	Experiment to Show Collective Diffraction of Light Waves	89
308	Electrical Resistance of a Conductor	89
309	Light Balance	89
310	Electronic Periodic Table	89
311	Bulb Lens Simple Microscope	89
312	Fluidless Manometer	89
313	Mirror View	89
314	Fun in Mathematics	89
315	Set Teaching Puppet	89
316	Relative Velocity	89
317	A Device For Quadratic Equations	89
318	Astrolobe	89
319	Paintsprayer for Multi Use	89
320	Railway Technique of Curve Tracing	89
321	Semiconductor Identification Testing and Analyser (SITA)	89
322.	New Approach to ECE of an Element	89
323	Electrolysis in a Rut-Shell	89
324	Ball Bearing Model	89

325.	Teaching Aid for Geometry	89
326	Small Holder's Dryer for Plantation Crops	90
327	Solar Distillator	90
328	Sound Operator Relay	90
329	Construction of Biochemical Energy	90
330	Lifting Foils	90
331	Solar Air Conditioner	90
332	Solar Cooker	90
333	Electronic Mosquito Repellant	90
334.	Track Tracing Robot	90
335.	Electronic Organ-Cum-Transmitter	90
336	Magnetic Weight Lifter	90
337.	Multipurpose Machine	90
338	Timer for Three Hours	90
339	Astronomical Telescope	90
340	Thermocole Cutter	90
341	Balance for the Blind	90
342	Automatic Fire Controller	90
343	Weight Balancing Capacity	90
344	Automatic Photo Controlled Switch	90
345	Account Keeper	90
346	Hi-Fi Colour Light by Computer Process	90
347	Transmission of Message	90
348	Flood Alarm	90
349	Bonsoi	90
350	Head Light Warner	90
351	Celestial Lamp	90
352	Writing Pad for the Handicapped	90
353	Pencil Seller	90
354	Water Harmonium	90
355	Log-Thief Alarm	90
356.	Two-Way Telephone	90
357	Electronic Revolution in India	90
358	Automatic Rain Indicator	90
359	Time Recording Rain Gauge	90
360	Musical Door	90
361	Fire Alarm	90
362	Model of a Galvanoscope	90
363	Optical Teaching Aid	90
364	Mathematical Teaching Aid	90
365	Drishya Shrubya Black Board	90
366.	Electronic Configuration	90

367.	Wave Motion	90
368	Working Model of Hearing Mechanism	90
369	Ripple Tank	90
370	Teaching Aids Showing Reflaction and Refraction	90
371	Low Cost Teaching Aids	90
372	Prayogic Vidhi Dwara Ganit Sidh Karna	90
373	Numerical Scale/Periodic Table (Chem)	90
374	Switching Circuits	90
375	SIUBA-V Semi-Conductor Application	90
376	Conversion of Mechanical into Electrical Energy	90
377.	Ripple Tank	90
378	Convection of Air	90

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2	Modern Harvester	85
3	Modern Threshing Machine	85
4	Sprayer	85
5	Farmer's Harrow	85
6	Multipurpose Bullock Cart	85
7	Novel Method of Drying Pulses	85
8	Seed/Fertiliser/Insect /Sprayer	85
9	Automatic Underground Irrigation	85
10	Land level Indicator	85
11	Water Sprinkler	85
12	Threshing Machine	85
13	Biogas From Non-edible Agriculture Waste	85
14	Waste Rice Husk into Black Gold	85
15	Village Cottage Industries	85
16.	Mizo Handmade Cotton Scutching Machine	85
17	Scientific Chulha	85
18	Roomheater/Water Heater-cum-cooking System	85
19	Biogas from Domestic Waste	85
20	Desert Herb Refinery	85
21	Improved Mechanical Grinder	85
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24	Extraction of Tulsi Oil	85
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26	Saral Gas Khad Plant	85
27	Black Oil Burner (Stove)	86
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30	Wind Operated Scare Crow	86
31	Maize Scrapper	86
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34.	Spray Machine	86
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36	Battery Operated Fertilizer Spread	86
37	Domestic Refrigerator	86
38	Earthen Refrigerator	86
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40	Nutrition	86
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44	Seed Tester-cum-Fire Alarm	86
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59	Handloom for the Handicapped	87
60	Water Management	87
61	Pesticide Sprayer For the Handicapped	87
62	Tubewell with Bamboo Accessories	87
63	Home Made Portable Sprayer	87
64	Spray Pump	87
65	Hand Oil Expeller	87
66	Husking (Paddy) Machine	87
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69	Water Stove	88
70	Water Pump	88
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204	Integrated Fertilizer Complex	90
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206	Scientific Kitchen	86
207	Detergent and Photosynthesis	89

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7	Technology for Industrial Progress	85
8	Multipurpose Steam Plant	85
9	Electricity from Sea Waves	85
10	Conveyor with counter	85
11.	Indigenous Paint Sprayer	85
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13	Vapour Degradation	85
14	Extraction of Rubber	85
15	Elevator	85
16	Cutting Machine for the Physically Handicapped	85
17	Dish Washing Machine	86
18	Time and Fuel Saving	86
19	Mini Micro-Hydroelectric Project	86
20	Rural Fridge	86
21	Hydraulic Robot	86
22	Home Textile Printing	86
23	Industry at Home	86
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25	Low Cost Refill Machine	86
26	A new Model of Loom for the Physically Handicapped	86
27	Spot Welding Machine	86
28	How to make Refills	86
29	Dye Preparation and Procedure	86

30	A Solar Furnace	86
31	Air Generator	87
32	Desalination by Electrodialysis	87
33	Multipurpose Machine for the Handicapped	87
34	Telecommunication	87
35	Intercom Set in Transmission System	87
36	Household Washing Machine	87
37	Plastics Extrusion	87
38	Automatic Switch for Electric Motor	87
39	Washing Machine	88
40	Innovative Water Lifting Pump	88
41	Irrigation by Windmill	88
42	Modern Hand Pump	88
43	Ocean—the Friend Forever	88
44	Electricity from Marine Water	88
45	Energy from Tidal Power	88
46	Harnessing Energy from Tides	88
47	Marine Instrumentation in Ocean	88
48	Innovative Measures for Extraction of Metals	88
49	Hydro-Electric Power Station	88
50	Jal Chalit Crane	88
51	Multipurpose Water Turbine	88
52	Steam Crane	88
53	Hand-made Paper Board Slate	86
54	Matchbox Industry at Home	86
55	Tie and Dye and Batik Painting	86
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58	Industrial Chemical from Prawn Shell	86
59	Solar Candle Making Device	86
60	Casip Roof and Tiles	87
61	Science, Technology & Industries	87
62	Model of Bombay High	88
63	Extraction of Petro-chemicals	88
64	Extraction of Metals from Ocean	88
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67	The World Beneath the Ocean	88
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71	Udyogon Ki Suraksha	87

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77	Multipurpose Hearth	89
78	Geo-Thermal Electric Plant	89
79.	Multipurpose Hearth	89
80	Energy of the Future	89
81	Solar Cooker	89
82	High Efficiency Wind Operated Dynamo	89
83	Electricity From Sea Waves	89
84	Ocean Thermal Energy Converter	89
85.	Gramin Vidyut Jantra	89
86	Electricity from Sea Waves	89
87	Automatic Switching of Street Light	89
88.	Solar Water Heater	89
89.	Tracking the Sun for Solar Energy	89
90	Production of Thiokol Rubber	89
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93	Importance of Lasers in Today's World	89
94	Count Down	89
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99	Paddy Thresher and Water Drawing Machine	90
100.	Silk Rearing Cycle and Industry	90
101	Collapsable Turbine Generator	90
102	Saving Energy Device	90
103	Imaginative Hydro-Electric Generator	90
104.	Nuclear Power Plant	90
105	Renewable Source of Energy	90
106.	Solar Cooker	90
107	Tent Solar Drier	90
108	Thermal Plant	90
109	Happy Home	90
110	Steam Engine with New Technology	90
111	Wealth from Water Hyacinth	90
112	Waste Plastic Plant	90
113	Auto-Wheeler Project	90

114	Re-aliving Machine	90
115	Separation of Wasteful Products from Industrial Fuel and Water	90
116	Recycling of Paper	90
117	Thread Winding Charkha	90
118.	Bed Carpet	90
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122	Simple Safety Device for Industries	90
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128.	Head Light Warner	90
129.	Celestial Lamp	90
130	Flexible Railway Bridge	90
131	Radar	90
132	Electronic Revolution in India	90
133	Vacuum Pump	90
134	Automatic Rain Gauge with Time Indicator	90
135	Time Recording Rain Gauge	90
136	Integrated Fertilizer Complex	90
137.	An Ideal Automobile for India	90
138	Swachalit Rail Safety System	90
139.	Remote Control System	90
140	Electronics to Prevent Train Collision	90
141.	Reclamation of used Engine Oil	90
142	Auto-Reverse Train	90
143	Automatic Water Level Signalling Railway Bridge	90
144.	Easy Computer	90
145	Conversion of Mechanical Into Electrical Energy	90
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147	Charkha Changer	85
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149	Production of Torch Cell, Novel Method	85
150	Handmade Cyclostlye Machine	85
151	Gelatine Duplication	85
152	Improved Mechanical Grinder	85
153	Threshing Machine for the Handicapped	85
154	Machine for Paper Bowls & Plates	85
155	Vegetable Cutter	85

156	Grinder	86
157	Domestic Mixy	86
158	Grinder with Cutter	86
159	Labour Saving Curd Churner	86
160	Design of House Which Floats During Floods	86
161	Modern Potter's Wheel	86
162	Kattha Making	86
163	A new Model of Loom for the Physically Handicapped	86
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165	Cotton Spreading Machine	87
166	Fibre Twisting by Improvised Gandhi Charkha	87
167	Paddy Thresher	87
168	Churning Machine for the Handicapped	87
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170	Pesticide Sprayer for the Handicapped	87
171	Transport and Communication	87
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173	Automatic Fire Bell and Fire Extinguishing Instrument	87
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175	Thread Making Machine	87
176	Home Made Portable Sprayer	87
177	Marble Processing Plant	87
178	Two-in-One Warping Drums	87
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181	Automatic Flush System	88
182	Improvised Air Cooler	88
183	Scientific Kitchen	86
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188	Cleano irrogo-Drinko Capacitor	88
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195	Jib Crane	89
196	Improvised Duplicator	89
197	Auto Protector of Bank Robbery	89

198	Paint Sprayer for Multiuse/Pressure of Air	89
199	Simple Safety Device for Industries	90
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5.	Scientific Chulha	85
6	Multipurpose Steam Plant	85
7	Room Heater/Water Heater Cum Cooking System	85
8	Electricity from Sea Waves	85
9	Production of Torch Cell by Novel Method	85
10	Biogas from Domestic Waste	85
11	Solar Water Heater	85
12	Sewage Treatment & Energy Recycling	85
13	LPG Consumption Measuring	85
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16	Saving of Energy & Work	86
17	Black Oil Burner (stove)	86
18	Solar Drier	86
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20.	Domestic Mixy	86
21.	Generation of Electricity	86
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171	Multiuse of Wind Energy	89
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APPENDIX-II

Preparations in Advance/Solutions to Problems (given on) pages

I. Initial Problems

(1) Look at the titles of exhibits displayed during the six years in pages 3-7 Try to appreciate the innovation in 11 exhibits mentioned in I. Also examine the trend and sections 2 and 3 of chapter I You will certainly be able to identify what you are looking for

(2) Surely you are the person who can do it.

(3) Start working in your area of interest Try the simplest exercises given in Chapter III This will give you some confidence. Gradually take up more hands-on activities You will find that you are not alone

(4) You are to tell your teacher and parents your difficulties

(5) Keep on dreaming, note down your ideas so that those are not lost. Try simple projects on the lines of titles of projects given in pages...

(6) Besides taking help of your teacher, consult all repair shops, technicians and craftsmen in your locality Everybody will help you.

(7) If you take interest, your progress with the tools will be very fast.

T

II. Problems of Execution

(8) Ask questions about all materials of construction around you; get answers from your teachers and elders Notice the materials and constructions of doors, windows, tables, chairs etc

(9), (10) and (11) Take up with your teacher again and again Take help of local craftsmen.

(12) This is quite natural; don't stop till you are satisfied.

(13) Read safety precautions and first aid carefully in Chapter III

(14) Nobody on earth is expected to get a better result of the first attempt without taking help of any expert. You are on the path to success

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III Problems of Transportation

(15) Construction should be modular so that individual parts can be packed separately (you can observe how an electric fan is packed before transportation) See that each packing is small enough to be carried in a bus Ideally the maximum size of one packing should be limited to the space under the seat of a bus

(16) Delicate parts are to be embedded in a thermocole sheet so that there is no room for movement of the parts The sheet is to be packed subsequently

(17) Use transparent perspex in place of glass wherever possible. Try to buy best quality glassware i e. test tubes, beakers etc of 'Borosil' make (18) Already discussed at (15) (19), (20) & (21) It is forbidden to transport inflammable materials like petrol, kerosene, spirit, films, gun powder etc. Acids and a few other chemicals which are either hazardous or can cause fire(when in contact with some other substances) are also not to be transported at any cost. Plan your exhibit keeping this limitation in mind However, the exhibition authorities might be able to arrange some of those for you locally You are to write to them in advance

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IV. Problems During Display

(22) This happens quite frequently This is due to the fact that during its trial you have not run your working model continuously for 3 hours or more

(23) You have to share the load of spoken words evenly with your fellow students or you might like to use a tape recorder The best course would be to communicate through written words and picture Remember that a picture is worth ten thousand words

(24) Carry medicines which you generally take Consult the doctor at site

(25), (26), (27) Already discussed at (23) It appears that your exhibit is very popular Arrange a rope or barrier to avoid stampede The visuals should be large enough to be seen at least from 3 metres

V Problems in Exhibition Pavillion

(28) Generally electric connection to individual tables are not proper. The common faults are thin size of wire, no earth wire, no conduit, old wire having no insulation at many points, loose plugs etc These are to be looked after by the organisers, but you are to bring these to their notice Safety precautions against electric shock and short circuits, first aid etc. are outlined in chapter..

(29) Adequate illumination without glare to anybody has to be ensured

(30) The organisers are to be requested to keep the volume of PA system low enough to avoid interference in presentation. Chosen instrumental music at an appropriate low volume may be played to make the atmosphere cheerful

(31) Hazardous experiments with inflammable materials are to be banned by the organisers. Open flames should also not be allowed Sufficient fire fighting equipment should be made available near each stall by the organisers

(32) Never compromise safety Faults on the live wire are attended by the site electrician Take his help as much as possible. If the circumstances compel you to repair connections with live wire, do it with the help of your teacher or electrician quietly after temporarily closing your counter

(33) You are to strictly abide by the instructions of the organisers

(34) Make sure what you are drinking is really potable The best course will be to fill your own water bottle when you are coming to the pavilion.
(35) As far as possible your exhibits should be designed to run on mains as well as battery. In case of power failure, alternative power supply from generator is to be arranged by the organisers.
(36) The exhibits are to be covered when you leave them in the evening.
(37)Practise how to assemble and dismantle in your school before leaving for the exhibition.
(38) Preserve carefully all packing materials and tools when you unpack on the first day
(39) If you need other's help, request him much in advance.
(40) Your labour and ideas will be lost if the exhibit is not properly displayed in your school Display it in a suitable place in the school .with the help of your teacher.

APPENDIX-III

I. List of Contents of the Mini Tool Kit

1	Vice Jaw—40mm x 9 mm, maximum jaw opening—40mm, Clampable to table top of thickness from 10 mm to 40 mm, material—cast iron, weight—675 g approx. Size when unscrewed-130 mm x 150 mm x 40mm	1 No
2	Half Round Wood Rasp 150 mm with handle	1 No
3.	Multitool body	1 No
4	Carpentry saw to be used with 3 above length - 210 mm, 3 teeth per cm, tapering width 30 mm/15 MM	1 No
5	Carpentry chisel, 6 mm bit width, 65 mm long to be used with 3 above	1 No
6.	Screw driver, 4 mm bit width, 65 mm long to be used with 3 above	1 No
7.	Triangular file, 100 mm, to be used with 3 above	1 No
8	(a) Collet, capacity to hold drills upto 6 mm dia, to be used with 3 above	1 No
	(b) flat drills	2 Nos
9.	Junior hacksaw Length-240 mm of dia. frame rod—6 mm nickel plated, to hold blade size of 150 mm x 6 mm	1 No
10	Cutting blades, steel, 150 mm x 6 mm	4 Nos
11.	(a) Hammer with handle, wt-160g handle 6 mm sq. x 185 mm long m.s. (b) pin (c) wire suspension (d) pan	1 each
12	Tin cutter cum pliers, 200 mm	1 No
13.	Bicycle wrench, 150 mm	1 No
14	Steel ruler, 150mm	1 No
15.	Divider, 100mm	1 No
16.	Centre punch, 75 mm long to be used with 3 above	1No
17.	Magnet (ferrite) 18 mm x 10 mm x 5mm	1 pair
18	Soldering Iron, 25 watts	1 No
19	Connecting wires with crocodile clips —200 mm long	3 Nos
	—300 mm long	3 Nos

20	Cell holder for two R-6 cells, Plastic body, brass/copper terminals (plated)	1 No
21	Polyfab bag 320 mm x 250 mm	1 No
22	Container box 270 mm x 175 mm x 80 mm, 28 swg, empty weight 800 g approx	1 No

CONSUMABLES

23.	Wood screw 30 mm	2 Nos
24.	Wire/ply nails assorted	25 g
25.	Sand paper 210 mm x 140 mm	1 No
26.	Emery paper 100 mm x 75 mm	1 No
27.	Soldering wire	5 g
28	Soldering paste	1g
29.	Dettol in 5 ml plastic bottle	
30	Cotton surgical	10 g
31	Grease	20 g

Additional items to be procured locally by the user and placed in the kit

1 Cell 2 nos. each 14 mm dia x 50 mm long, 1. 5V, R-6
2 Torch bulb 1.5 V, Screw type with holder having terminals
3. Three pin plug for the soldering iron
4. Fevicol bottle (small)
5. Steel knife, 75 mm long blade with rounded tip (should not be very sharp)
6. Battery eliminator.
7. Oil stone, 15 mm x 25 mm x 100 mm (approx) in a wooden box.
8 Brush, 50 mm
9. Small lock and key

List of some handtools to be procured locally when students have mastered the given handtools and desire to take up more complicated projects

1 Twist drills from 3 mm to 6 mm
2. Set of metal working files
3. Hacksaw
4. Adjustable wrench, 150mm
5 Pliers
6 Inside and outside caliper.
7 Try square
8. Carpentary planer's
9 Vernier caliper
10 Electrician tool (having functions of wire stripper, cutter, screw drive crimper and wire looper in one tool).

APPENDIX-IV

Science Club Kit: List of Items

1. Plane 225 mm
2. Carpenter's saw 300mm
3. Tendon saw 300 mm
4. Firmer chisel with handle—19 mm
5 Bevelled chisel with handle—12mm
6 Mortise chisel with handle—6 mm
7 Half round bastard file with handle— 250 mm
8. Vice with Lab Stand rod, boss head and Clamp
9 Hand drilling machine,. 6 mm
10. Twist drill bit, H.S S 5 mm dia
11 Screw driver with handle 100 mm
12. Flat file with handle 250 mm
13. Flat file with handle 150 mm
14. Half round file with handle 150 mm
15. Round file with handle 6 mm dia, 150 mm long
16. Triangular file with handle 100 mm
17. Hacksaw 300 mm with (a) collapsible frame, adjustment screw and nut, handle (b) 3 blades.
18 Junior Hacksaw with 6 blades
19 Multitool
20 Ball pein hammer with handle 225 g
21 Combination side cutting plier, 150mm
22. Soldering iron 25 W with plug
23 Electrician's tool
24 Centre punch
25 Scriber
26 Inside caliper—150 mm
27. Outside caliper—150 mm
28. Protractor 100 mm
29 Divider 150 mm
30. Steel Scale 150 mm
31 Try Square 150 mm
32 Vernier cal-liper 0-150 mm
33. Ammeter O-1mA
34. Pair of connecting leads for ammeter (black and red) 800 mm long.

35 Thermometer (-10° to 100°C) with case
36 Postal balance capacity 250 g
37 Magnifying glass, f.l. around 100 mm, 50 mm diametre
38 Measuring cylinder 100 ml
39 Knife 12 mm x 100 mm
40 Brush 50 mm
41 Oil stone 12 mm × 12 mm × 100 mm (smooth)
42 Sewing needle 100 mm—3 Nos
43 Crocodile clips—6 Nos
44 Terminals for electric circuits—1 dozen
45 Nails 18 swg, 25 mm - 50 g
46 Nails 18 swg, 12 mm - 50 g
47 Wood screw 18 mm long - 50 pieces
48 Machine screw flathead, M3 with nut and washer 20 mm long - 20 pieces
49 Flat head aluminium rivet 3 mm dia, 6 mm long 50 pieces
50 Flathead Aluminium rivet 1 5 mm dia, 6 mm long 50 pieces
51 Emery paper medium - 1 sheet
52 Sand paper fine - 2 sheets
53 Insulating tape
54 Cellotape
55 Soldering wire with paste
56 Polyfab tool bag
57 Kit box with lock and key
58 Bandage - 40 mm width - 1 small roll
59 Absorbent cotton wool - 1 small roll
60 Dettol - 1 small tube

APPENDIX-V

List of Items in the NCERT Science Van

Sl No	*Description*	*Quantity*
1.	Projection screen in metal container mounted on tripod stand	1
2	Projector film (16 mm) with extension speaker, transformer and other accessories	1 set
3	Slide-cum-film strip projector (35mm)	1
4	Casette tape recorder	1
5	Casette tapes, C-60 (60 minutes)	6
6	A set of 20 rock specimens	1 set
7.	A set of 31 Indian minerals	1 set
8.	A working model consisting of four globes	1
9	A set of charts	24
10.	Roll-up black board (plain)	1
11	Roll-up black board with graph	1
12.	Folding chair (Steel)	1
13	Table (transparent top)	1
14	Murah (straw cushioned puffy)	1
15	Alarm clock	1
16	Kerosene lantern	1
17	Plastic bucket (15 litres)	1
18.	Mug (plastic)	1
19	First-aid box	1
20	Microscope (high powered,	1 set
21	Microscope kit	2
22.	Geography kit	1
23	Star and satellite finder	1
24.	Polaroid light study kit	1
25.	A model of eye kit	1
26	A model showing persistence of vision	1
27.	A model of I.C. engine	1
28	A model of steam engine	1
29	Model of siren	1
30.	Polythene container (6 litres)	1
31	Polythene container (10 litres)	1

32	Electronic educational kit	1
33	Intercom set (with master and slave)	1
34	Biological models (human torso, etc)	15
35.	Crooks radiometer	1
36	Acid accumulator	1
37	Spherometer model	1
38	Micrometer model	1
39.	Tools (workshop tools, engine tools, electrical tools, generator tools, etc	50 pieces
40	Searchlights	2
41	Torch (3 cells)	1
42	Canvas canopy	1
43.	Canvas tent	1
44	Slides	200
45	Film (educational), 16 mm	5 reels
46	Wash basin	1
47	Water tank	1
48	Centrifugal pump with tubing and foot valve	1
49	Motor 0.18 kW pump with casing	1
50	Wooden box (back to driver's seat)	2
51	Science kits (a) primary science	1
	(b) Physics I and II	2
	(c) Physics III	1
	(d) Biology composite	1
	(e) Chemisity demonstration	1
52.	Demonstration platform on wheels	1
53	Switchboard with cord	2
54	Bulbs	6
55.	Working table (adjustable)	1
56	Generating set with exhaust manifold Vijkar President, M/C No 123 Generator . 2kW	1 set
57	Educational toys (assorted)	
58	Fan (small model)	1
59	Books, literatures and leaflets	60
60	Jeep (Mahindra & Mahindra) Chassis No (FC-160) Sr No. 7303298-F Engine No 7303298-F Serial No. 109451, Year 1973	1
	(a) Spare stepney (complete)	1
	(b) Fitted with sliding glass partition	1 pair
	(c) Fitted with hinging boards	

(d) Fitted with compartments on two sides
(e) Long box with lid
(f) Rails and guides on top.

APPENDIX-VI

Communication Materials Used by Bharat Jan Vigyan Jatha

Slide Shows

INTRODUCING THE UNIVERSE· 30 slds, 30 mins Aspects of Astronomy about earth, solar system, sun, stars, galaxies etc

EVOLUTION OF MAN. 30 slides, 20 mins. The story of evolution

TECHNOLOGY AND SOCIETY· 70 slides; 30 mins Development of tools, implements and machines down the ages linked to the needs of society and the effect of their use on society

MAN AND ENVIRONMENT: 70 slides, 30 mins The condition of our environment -forests, rivers, oceans, air-and the means to keep them clean

UNDERSTANDING FORESTS· 70 slides; 30 mins How forests develop and thrive, their importance-a bunch of trees is not a forest.

HEALTH AND DISEASE 125 slides, 60 mins all 3 separate shows on Diarrhoea Nutritional diseases and Leprosy what, how, why and wherefore

ON PEACE 100 slides, 40 mins The Arms Race since Hiroshima, the setback in development, potential effects of nuclear war: arms race or human race?

FOOD ADULTERATION· 60 slides; 20 mins Dangers of, and how to detect it

WOMEN AND REPRODUCTION 30 slides, 20 mins Explication of biological processes and mechanisms, and focussing on erroneous beliefs and practices

Video Films

DARKNESS OF A THOUSAND SUNS: 25 mins On the horrors of Nuclear war and misuse of science, on the arms race--by whom and why--on the global peace movement and the need to be part of it

HEALTH AND SOCIETY. 30 mins On the scale and scope of ill-health and disease in India, on their social roots and therefore social measures against them The knowledge exists· but can we realise health for all by 2000 AD?

*STILT-FOOTED: 25 mins On dependence on borrowed technology In Indian Industry, the need for realising our potential and "walking on our own feet". (some other films, while not made for the Jatha will also be used in local programs.)

Poster Exhibitions

SCIENCE THROUGH THE AGES· 30 panels— A brief historical overview of major scientific Inventions and discoveries from early Stone Age tools to modern rockets and nuclear power plants

INDIAN SCIENTISTS: 30—panels portraits of great contributors to science In India, from

ancient to modern times, with brief description of their work
MILKY WAY TO MAN 40 panels—Evolution of the Universe and the evolution of human kind
COMMON HEALTH PRACTICES· 30 panels—Analysis of prevalent misconceptions about health and treatment of ailments. focusses on the common cold, on Injections, on tonics and "health foods"
WHAT IS SCIENCE 30 panels—An Imaginative portrayal of the scientific enterprise and attitude, their objectives and methods.
DARKNESS OF A THOUSAND SUNS a photo-essay on the nuclear war-danger in atlas-size booklet--an invaluable resource-book.

Toys, Kits and Models

Microscope with projector Telescopes (Rack and pinion and small drawer,) Bead dissection/projection Microscope
Sundial kit
Sextant kit
Star Clock, Star and Satellite path-finder, periscope, Stroboscopic toys + 10 Cards, Magnetic Compass, Mage Hemis 3" dia, Optical experiment kits and lenses Ceramic and Rubberised Magnet sets Teleidoscopes (kaleidoscopes that see out), Optical illusion kits and chart Obedient Balls, Submarine and hovercraft models, 20 & 45 cm Wingspan gilders (hand/catapul), Hot-air balloon kit (pre-cut & Al foil), Gyro toys, Big Rubber Balloons (Meteorological), Coil spring, Fresnel Lenses kits, Wind mill working models (sail with pump)

Non-Member Organizations

A.P. Vigyan Parishad * Arogya Dakshata Mandal (Mah) * Assam Science Society * Centre for Social work and Research (Tri) Delhi Science Forum * Doon Science Forum (U P) * Eklavya (M P) * Gujarat Vigyan Sahitya Sabha * Haryana Vigyan Manch * Himachal Vigyan Manch * Karnataka Rajya Vijnana parishad * Kerala Shastra Sahitya parishad * Lok Vidnyan Sangatana (Mah) * Madhya Pradesh Vigyan Sabha * Marathi Vidnyan parishad * Medical Science Forum (Bih) * Paschim Banga Vigyan Manch (WB) Peoples Health Forum (Punjab) * Pondicherry Science Forum * Praja Chaitanya Vedica (A P) * Tamil Nadu Sceince Forum * Tripura Science Forum * Vigyan Prachar samity (Orissa) * Federation of Medical Representatives Associations of India * National Association of Indian Doctors for Prevention of Nuclear War *
National Cenfederation of Officers Associations of Central Public Sector Undertakings

Source· NCSTC

APPENDIX-VII

NCSTC Software

Slide Sets

The following slide-sets which were used during BJVJ in 1987 are now available from NCSTC. With each set, a script in English of the slide show would also be available. The subjects and numbers of slides in the sets available are as follows.

	Subject	*Number*	*Cost (In Rs.)*
1.	Man and Environment	65	227.50
2.	Leprosy	36	126.00
3.	Into the Cosmos	65	227.50
4.	Diarrhoea	40	140.00
5.	Disease of Nutritional Deficiency	48	168.00
6.	Women's Reproductive System	30	105.00
7.	Understanding Forests	55	192.50
8.	Man and Evolution	20	70.00
9.	Food Adulteration	60	210.00
10.	Technology and Society	79	276.50
11.	Science for peace	79	276.50

Packing and transportation charges are included in the prices listed above.

"Method of Science" Exhibition

The Hindi and English versions of the 76-panel, "Method of Science" exhibition, devised by Eklavya, Bhopal (MP), are now available in two models (one is portable, the other is a sturdier, with panels on hard/card board, and metal stands, more of a permanent type) on the prices given below.

	Normal Price		*Subsidy to Voluntary agencies*
i)	Portable Version	Rs 415	50%
ii)	Sturdier Version	Rs 6,000	20%

Packing and transportation charges will be extra as per actuals. One copy of the bilingual booklet on exhibition is sent free with the portable version and five with the other version.

Publications:

Method of Science (bilingual booklet on exhibition)	Rs. 25 00

DO-IT-YOURSELF SERIES

Leaf Zoo	Rs 10.00
Pump from the Dump	Rs.10.00
Toy Joy.	Rs 15 00
Low Cost Experiments	(under preparation

Please send payment in the form of Demand Draft drawn in favour of "Vigyan Prasar" New Delhi payable at the Union Bank of India, Safdarjung Development Area Branch, New Delhi-110016 to Accounts Officer, Vigyan Prasar, Department of Science and Technology Bhawan, New Mehrauli Road Delhi-110016.

Copies of NCSTC Films

(a) Video- cassettes copies in VHS format of the following award winning NCSTC fillms are now available from ET & T sales outlets

1. C V Raman The Scientist and his Legacy (43 Min.)
2. The Enigma of Srinivasa Ramanujan (36 Min.)

(b) VHS copies on 13 cassettes (one for each episode) of NCSTC's widely acclaimed Hindi film serial on the history of science and technology in the Indian subcontinent, Bharat Ki Chhaap, are now also available The 13 titles are

Bharat ki Chhaap- 1 Introduction (51 min.)
Bharat ki Chhaap- 2 . The Stone Age (52 min)
Bharat ki Chhaap- 3 · The Harappan Civilisation (54 min)
Bharat ki Chhaap- 4 The Iron Age (51 min)
Bharat ki Chhaap- 5 The Age of Codification (51 min)
Bharat ki Chhaap- 6 Ayurveda and Astronomy (53 min)
Bharat ki Chhaap- 7 · Mathematics and Temple Architecture (50 min.)
Bhariat ki Chhaap- 8 Pre-Mughal and Mughal (52 min)
Bharat ki Chhaap- 9 The Early Colonial Period (51 min)
Bharat ki Chhaap-10 Impact of the Industrial Revolution (55 min.)
Bharat ki Chhaap-11 · The Freedom Struggle and The New Physics (50 min)
Bharat ki Chhaap-12 : Independent India (54 min)
Bharat ki Chhaap-13 Conclusion (48 min)

The cost of each cassette is Rs. 105/- C S T , Packing and transportation charges will be extra as per actuals Contact any of the Electronics Trade and Technology Development Corporation Ltd (ET & T) outlets near you for further imformation

Source NCSTC

APPENDIX-VIII

Setting up a Ham Club Station

In one of our previous issues (Number 11, December 1989), we had outlined our scheme for promoting Ham (amateur) radio activity in the country The idea was to develop a net work of amateur radio stations coordinated by NCSTC. The State Councils/Departments of Science and Technology of all the States/union territories had expressed enthusiasm and willingness to participate in and promote this activity in their respective States Such efforts would generate interest in this exciting scientific hobby as well as in science and technology in general. Here, we will briefly outline the steps and actions required for the establishment of a Ham club station, and for conducting related activities.

Basic Requirements

Ham radio is basically a hobby. A Ham station can be established by any individual possessing a valid Amateur Station Operator's Licence (ASOL) issued by the Ministry of Communications, Government of India To obtain an ASOL, it is necessary for an individual to pass an examination, conducted by the Ministry of Communications, that includes topics such as basic radio theory, rules and regulations, and communication through Morse-code A Ham station can also be established by an amateur radio society, a club, a school, a college, an institute, or a university in India; only, the secretary or the officer-in-charge of a station must necessarily be a radio amateur or a Ham himself/herself. The officer-in-charge of a club station should hold a valid Grade-I ASOL

The requisite application forms for establishing an amateur radio club station, can be had from the Assistant Wireless Adviser, Government of India, WPC Wing, Ministry of Communications, Sanchar Bhavan, 21 Ashoka Road, New Delhi- 110 001. The following enclosures must accompany the completed application form, in order to establish a club station

(i) A copy of the constitution of the amateur radio society/club,
(ii) Aims and objectives of the society/club,
(iii) Names of the office-bearers of the Society/club;
(iv) Mode of operating the society/club including its normal hours of work,
(v) Particulars of the apparatus to be used,
(vi) Particulars of the authorised official of the society/club in whose favour the licence is desired, alongwith attested copies of his birth and nationality certificates,
(vii) An attested copy of the individual ASOL of the authorized official who would act as the Officer-in-charge of the club station,
(viii) Minutes of the meeting held for establishment of an amateur radio club, including

a record of the decisions taken therein regarding the name of the proposed society/club nomination of its President, Secretary, Treasurer and the Members of its Executive Committee, and

(ix) A Demand Draft for Rs 100/- towards the licence fee for 5 years in favour of the Pay & Accounts Officer (Secretariat), Department of Telecommunications, New Delhi

Setting up a Club Station

Once a licence has been issued by the Ministry of Communications a club station can be set up Due to near non-availability of amateur radio equipment in our country, it is necessary either to import the required equipment, or to fabricate the same with the technology and financial resources available. The Ham equipment, widely used all over the world is made in Japan. An average transceiver with some standard accessories costs around Rs. 25,000/- including import duty (levied at the rate of 40 per cent upto imports of Rs 20,000/- and higher for larger sums)

Each State S & T Council/Department should either get a staff member trained to pass the ASOL examination and obtain a Ham licence, or else arrange to provide Ham equipment to a selected individual who already possess a valid Grade-I licence, to establish their Ham club station The basic functions of such a club station would consist of demonstration of the working of Ham radio, training interested individuals to enable them to pass the ASOL examination, and involving them in various Ham-related projects and activities

Incidentally, experienced Hams in our country have been known to have fabricated low-power equipment out of used parts and spares picked up from the market at costs ranging from Rs 3,000/- to Rs 4,000/- NCSTC is also trying to take steps to arrange development of indigenous low-power, low-cost, Ham equipment, which would be amenable to production in fairly large numbers to really popularise this activity.

Source NCSTC Communications